



# MACHAKOS UNIVERSITY

## BOOK OF PROCEEDINGS

### OF THE 1ST MACHAKOS UNIVERSITY INTERNATIONAL CONFERENCE

THEME: HARNESSING SCIENTIFIC RESEARCH, INNOVATION  
AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

DAAD





# **MACHAKOS UNIVERSITY**

## **BOOK OF PROCEEDING OF THE MACHAKOS UNIVERSITY 1<sup>ST</sup> ANNUAL INTERNATIONAL CONFERENCE**

**DATE: 17<sup>th</sup> -19<sup>th</sup> APRIL 2018**

*Theme: Harnessing Scientific Research, Innovation and Technology for  
Sustainable Development*

**May, 2018**

## CONFERENCE SPONSORS



# MACHAKOS UNIVERSITY

## MANDATE

The core mandate of Machakos University is to Teach, Train, conduct Research, Innovate, Collaborate, generate new knowledge and Community Service

## IDENTITY STATEMENT

Machakos University is an academic institution committed in transmitting knowledge, skills and attitude through science, Technology and Innovation for the benefit of humanity

## VISION STATEMENT

A preferred University of Scholarly Excellence

## MISSION STATEMENT

Provide scholarly education through Training, Research and Innovation for Industrial and socio-economic transformation of our communities

## PHILOSOPHY STATEMENT

To provide transformative leadership in Teaching, Training, Research, Innovation, Industrial and Technology transfer for wealth creation

## CORE VALUES

**Integrity:** To honestly deliver on our promises to our stakeholders

**Accountability:** To always be accountable in the assigned duties

**Professionalism:** To be committed to high standards of training and service delivery

**Inclusivity:** Respect for diversity

**Creativity:** Determination to continually improve

**Teamwork:** To actively work together to achieve common goals

**Equity:** To strive to be an equal opportunity university where meritocracy is practiced in all areas

**MACHAKOS UNIVERSITY MANAGEMENT**



**VICE-CHANCELLOR AND PROFESSOR OF ENTOMOLOGY**

**HON. AMB. AMINA MOHAMMED**  
*CHIEF GUEST*



**Hon. Amb. Amina Mohammed**  
*Cabinet Secretary, Ministry of Education*

**Amb. Amina Mohammed** is a lawyer and diplomat, currently the Cabinet Secretary for Education, Republic of Kenya. Amina has previously served as chairperson of the International Organization for Migration and the World Trade Organization's General Council, as well as Assistant Secretary-General and Deputy Executive Director of the United Nations Environment Programme. She also served as the Cabinet Secretary in Ministry for Foreign Affairs in Kenya from May 2013 to February 2018.

For her elementary studies, Amb. Amina attended the Township Primary School in Kakamega and later Butere Girls and Highlands Academy. Amb. Amina then proceeded to Ukraine on a scholarship to study at the University of Kiev. She completed the institution's courses, earning a Master of Laws (LLM) in International Law and later a Postgraduate Diploma (PGDip) in International Relations from the University of Oxford.

## KEYNOTE SPEAKERS



### **PROF. HAMADI BOGA**

*Principal Secretary, State Department for Agriculture Research*

Prof. Boga is Professor of Microbiology in the Department of Botany at the Jomo Kenyatta University of Agriculture and Technology. He has been Principal of Taita Taveta University College and acting Vice Chancellor of Taita Taveta University. He is currently the Principal Secretary, State Department for Agriculture Research in the Ministry of Agriculture and Irrigation. **His speech is on Government synergies for Harnessing Scientific Research, Innovation and Technology for Sustainable Development.**



### **PROF. CHACHA NYAIGOTTI-CHACHA**

*Chairman, Commission for University Education*

Professor Nyaigotti-Chacha is [Swahili language](#) educationalist. He has served as an executive secretary of the [Inter-University Council for East Africa](#) (2000–2010), and was the first CEO of the [Kenyan Higher Education Loans Board](#) (1995–2000). He is currently serving as the Chairman of the Kenyan Commission for University Education (CUE) and the Kenya Institute of Mass Communication (KIMC). **His speech is on the Role of Universities in Harnessing Scientific Research, Innovation and Technology for Sustainable Development**



### **ENG. JOHN TANUI**

*Chief Executive Officer, Konza Technopolis Development Authority*

Eng. Tanui is the Chief Executive officer of Konza Technopolis Development Authority, a semi-autonomous government agency tasked with building Kenya's first smart techno city. Eng. John Tanui holds a Bachelor's Degree of Technology in Electrical and Communication Engineering from Moi University and MBA in International Business from the University of Nairobi where he is currently pursuing Ph.D. in global business management. He is a member of the Institution of Engineers of Kenya (MIEK), a registered engineer and a member of the Academy of International Business. **His speech is on Innovation and Technology for Sustainable Cities**

## GUEST SPEAKERS



### **Prof. Mary Abukutsa**

**Prof. Abukutsa** is Professor of horticulture and currently the Deputy Vice-Chancellor, Research, Production and Extension at Jomo Kenyatta University of Agricultural Technology. She is famed as a [humanitarian](#) and [agricultural scientist](#) from [Kenya](#) who specializes in [olericulture](#), [agronomy](#), [plant physiology](#) and her work focuses on African indigenous food crops. **Her speech is on Harnessing African Indigenous Vegetables for Africa's Sustainable Development.**



### **Prof. Mugendi M'Rithaa**

Prof. M'Rithaa is an industrial designer, educator and researcher at the Cape Peninsula University of Technology in South Africa. He holds postgraduate qualifications in industrial design and higher education, as well as a doctorate in universal design. M'Rithaa is passionate about various expressions of socially responsive and responsible design, including design for sustainability, participatory design, and universal design. **His speech is on an Afrikan Perspective on Socially Conscious Design.**



### **Prof. Birhanu Dejene**

Prof. Dejene is Professor of physics and material science at the University of Free State, South Africa. He has developed collaboration with University of the Western Cape, Nelson Mandela Metropolitan University, University of Nairobi, University of Eldoret, JKUAT, University of Addis Ababa, Tokyo Institute of Science and Technology, ICTP and Tsukuba University. **His speech is on Green Energy Sources as Solutions for Sustainable Energy for The Past, Present and Future through Community Engagement.**



### **Prof. Simmy Marwa**

**Prof. Marwa** is a Professor and practitioner of Strategic Quality Management at Dedan Kimathi University of Science and Technology. He is also a Certified Manager in Six Sigma Green and Black Belt, Process Excellence and Project Management as well as a Fellow of the Higher Education Academy (UK). **He will speak on Business and Innovative Approaches for Small & Medium Enterprise Development.**



### **Prof. Donald Kisilu Kombo**

Prof. Kombo holds a PhD in Sociology of Education, and currently the Acting Dean, School of Education, Kenyatta University. Some of the significant researches he has done include the Impact of Nairobi-Thika Super Highway on Ruiru Town in Kenya and Cactus Pilot Project on Health Promotion in Selected Primary Schools in Nairobi, Kenya. His areas of interest include Education, Research and Community Development. **His speech is on Innovative Theories and Models of Competency Based Education for Sustainable Development.**

## MESSAGE FROM THE VICE-CHANCELLOR



It is with great pleasure that I welcome you to Machakos University and to her 1st Annual International Conference on Harnessing Scientific Research, Innovation and Technology for Sustainable Development. This conference purposes to take an in-depth look at the many issues raised by global, regional and national interests, summarized as; Sustainable Development Goals adopted by the United Nations, Africa Union 2024 Agenda and the Kenya Government's Big Four Agenda.

As we may be aware, conferences provide moments to network and build collaborative synergies, so let us use it to form partnerships that shall continue on, beyond the three days that we shall be gathered here. Conferences also do carry salient feature; recruitment of faculty. For those seeking employment opportunities, do not hesitate to share with your fellow participants.

In welcoming you to Machakos University, I wish to share with you that since its inception as a Technical School in 1957, the university has made a niche in Innovation and Technology especially in mechanical engineering, clothing and hospitality. The researchers and scholars participating from various universities, industry and other organisations in sharing their knowledge, shall propel not just this university but the region in realizing the Kenya Vision 2030.

I welcome you all to interact freely not just amongst yourselves but also with the University community in our eight schools; School of Business and Economics, School of Humanities and Social Science, School of Pure and Applied Sciences, School of Education, School of Engineering and Technology, School of Hospitality and Tourism Management, School of Agriculture, School of Environment and Natural Resources, and School of Health Sciences.

Finally, I wish to thank our Chief Guests, Keynote Speakers, Guests Speakers and all the participants, for finding time to be with us during this important occasion.

Once again, welcome to Machakos University.

**Prof. Lucy W. Irungu, PH.D.**  
**Vice-Chancellor & Professor of Entomology**

## **MESSAGE FROM THE DEPUTY VICE-CHANCELLOR (RESEARCH, INNOVATION AND LINKAGES)**

I am delighted to welcome you to this auspicious occasion of our 1<sup>st</sup> Annual International Conference. Under the theme: **Harnessing Scientific Research, Innovation and Technology for Sustainable Development**, this conference is one of a number of important efforts that Machakos University is making towards the realization of Sustainable Development Goals, and the Government of Kenya Big Four Agenda in line with the Kenya Vision 2030. Through teaching, research and community service, Machakos University is in the centre stage in steering our country towards sustainable development by engaging in new knowledge generation, innovation and technology, sharing the knowledge and subsequent transfer to entrepreneurs. This is the rationale behind our conference theme.

Cognizant of the challenges and opportunities presented by the United Nations adoption of the Seventeen Sustainable Development Goals and the Government of Kenya's Big Four Agenda: Manufacturing, Food and Nutrition security, Health and Housing, the conference further cascades the theme of the conference into five sub-themes:

- 1) Agriculture, Food Security, and Agribusiness for Community Transformation
- 2) Transformative Development through Language, Culture and Communication Technology
- 3) Innovative Approaches to Education and Training for Sustainable Development
- 4) Business and Innovative Approaches for Small and Medium Enterprise Development
- 5) Science, Technology, Engineering, Mathematics and Innovation for Industrial Transformation

These sub-themes were crafted to embrace main drivers of sustainable development goals, namely: sharing knowledge through education; effective communication through technology; human explorations and imaginations through Science and Mathematics, sustainable, long-term growth and job creation through Small and Medium Enterprises and food for all through Agriculture and Food Security. All the sub-themes in the conference embrace innovation domains, as key driver in fast tracking economic growth based on knowledge. Innovation then must be treated as business critical in all sectors, for increased prosperity.

Preparation of the conference started in August 2017 and the first call we out in September 2017. A total of 225 abstracts from eight (8) countries were received and out of these, 190 were accepted. I therefore would like to welcome all these researchers to Machakos University and appreciate them for choosing to share their scientific and academic work in this conference. I also, on behalf of the conference committee, acknowledge and appreciate support received Machakos University, German Academic Exchange Service (DAAD), National Research Fund-Kenya, National Bank of Kenya, Standard Chartered Bank, Equity Bank, Agricultural Society of Kenya, Coca cola and Konza Technopolis Development Authority. The support made this conference possible.

I recognize our Chief Guests, Amb. Amina Mohammed, the Cabinet Secretary, Ministry of Education, for accepting to preside over the official opening of this conference and Hon. Dr. Alfred Nganga Mutua, the Governor of Machakos County for accepting to officially close the conference. I further recognize our Key Note Speakers; Prof. Hamadi Idd Boga, Principal Secretary for Agriculture Research, Prof. Chacha Nyaigotti-Chacha Chairman, Commission for University Education and Eng. John Tanui, the Chief Executive Officer, Konza Technopolis Development Authority. Guest Speakers; Prof. Mary Anyango Abukutsa, Prof. Simmy Marwa, Prof. Donald Kisilu Kombo, Prof. Mugendi K M'Rithaa and Prof. Birhanu Dejene. I appreciate fellow researchers from across borders, from our sister universities and Machakos University. Thank you for coming to share your experience and expertise at this event over the next three days. I appreciate the time, money and energy you have spent doing your research, writing your papers and travelling to this event.

Finally, this conference could not have been held without the support of my colleagues in the Conference Committee, which I Chair. This conference involved input of enormous amount of time and energy into various conference processes, thus ensuring success.

As a participant in this conference, I appreciate, Cristian Mihai Adomnitei, who once said:

(...) that we live in a period characterized by knowledge-based competition, in which the most valuable commodities are innovation and information in which science knows no boundaries and research is asked today to deal with issues that are increasingly global (...)

I wish you a successful conference, deliberations and networking throughout your stay during this Machakos University 1<sup>st</sup> International Conference.

*Thank you*

**PROF. PETER N. MWITA**  
Deputy Vice-Chancellor (Research, Innovation and Linkages)  
Machakos University

## MESSAGE FROM THE CHIEF GUEST

I am pleased to join Machakos University and all the participants on this special occasion of the 1<sup>st</sup> Annual International Conference on a celebrative theme **Harnessing Scientific Research, Innovation and Technology for Sustainable Development**. I find this conference quite timely because globally, the concern is no longer development, but sustainable development. Universities, in seeking to be centres of excellence in training, research and innovation for industrial and socio-economic transformation of our communities, must embrace sustainability. This I believe is what this conference is anchored on. Deliberations should focus, and I rightly believe so, on how to maximize the use of available opportunities and resources while being mindful of the future generations.



In perusing through your website on Conference updates for prior knowledge, I got optimistic that the sub-themes and subsequent abstracts will ignite thoughts and minds of researchers and scholars towards sustainable development. This I urge you to do in the light of Sustainable Development Goals as adopted by the United Nations, Kenya Vision 2030 and the Kenya Government Big Four Agenda: Manufacturing, Food and Nutrition security, Health and Housing. Truly, I thank the organizers for carefully crafting this sub-themes and the selection of papers to be presented.

I wish to thank the participants for finding time to research, write papers and travelling from various places to come and share your experiences in this conference. I congratulate Machakos University for this effort and a job well done. I extend my best wishes to the organizers and all participants for success of the Machakos University 1<sup>st</sup> International Conference.

Thank you.

**Amb. Amina Mohammed**  
Cabinet Secretary,  
Ministry of Education, Republic of Kenya

# CONFERENCE PROGRAMME

## OFFICIAL OPENING AND KEYNOTE ADDRESSES

Time	DAY 1: TUESDAY 17 <sup>TH</sup> APRIL 2018	In-charge
8:00-9.00	Arrival and Registration and Brief Entertainment	Secretariat
9.00-10.30	<b>OFFICIAL OPENING OF THE CONFERENCE VENUE: KILIMAMBOGO HALL</b>	
	Welcoming Remarks, <b>Prof. Peter Mwita</b> (DVC- Research, Innovation and Linkages, Machakos University)	Secretariat
	Opening Address, <b>Prof. Lucy Irungu</b> (Vice-Chancellor, Machakos University)	<b>Prof. Peter Mwita</b>
	<b>SPEECH AND OFFICIAL OPENING OF THE CONFERENCE BY THE CHIEF GUEST: HON. AMB. AMINA MOHAMMED, CABINET SECRETARY, MINISTRY OF EDUCATION</b>	<b>Prof. Lucy Irungu</b> Vice-Chancellor, Machakos University
10.30-11.00	<b>PHOTO SESSION AND HEALTH BREAK</b>	Secretariat
11.00-11.30	<b>Prof. Hamad Idd Boga (Principal Secretary for Agriculture Research)</b> <i>Government synergies for Harnessing Scientific Research, Innovation and Technology for Sustainable Development.</i>	<b>Prof. Peter Mwita,</b> DVC-RIL, MKsU
11.30-12.00	<b>Prof. Chacha Nyaigotti-Chacha (Chairman, Commission for University Education)</b> <i>The Role of the Universities in Harnessing Scientific Research, Innovation and Technology for Sustainable Development.</i>	<b>Prof. Joyce Agalo,</b> DVC-ASA, MKsU
12.00-12.30	<b>Eng. John Tanui (Chief Executive Officer, Konza Technopolis Development City)</b> <i>Innovation and Technology for Sustainable Cities</i>	<b>Prof. Douglas Shitanda</b> DVC-APF, MKsU
12.30-1.00	<b>Plenary (Key Note Speakers)</b>	<b>Prof. Charles Ombuki-Chairman</b> <b>Dr. Larry Ndivo-Rapporteur</b>
1.00-2.00	<b>LUNCH BREAK</b>	

**SUB-THEME: AGRICULTURE, FOOD SECURITY, AND AGRIBUSINESS FOR  
COMMUNITY TRANSFORMATION**

<b>DAY 1: TUESDAY 17<sup>th</sup> APRIL 2018: CONFERENCE PRESENTATION SESSIONS</b>		
<b>VENUE: THATHA HALL</b>		
<b>Time</b>	<b>Title</b>	<b>In-Charge</b>
2.00-2.20	<b>Michael Elias, Uwe Richer, Oliver Hensel, Christian Hulsebusch, Oliver Wasonga:</b> <i>Mapping Cultivation Expansion in the Rangeland; Determinants and Implications on Pastoral Land use Systems in Borana Southern Ethiopia</i>	Dr. Jacob Konyango (Chair)  Dr. Alice Kosgei (Rapporteur)
2.20-2.40	<b>Ezekiel Mbitha:</b> <i>Gender, Land Ownership and Food Production Nexus in Mbeere Drylands, Kenya: Implications on Household Food Security</i>	
2.40-3.00	<b>Koima J. Agness:</b> <i>Assessment of Mango Post-harvest Losses in Mwala Sub- County</i>	
3.00-3.20	<b>David Stelamaris Velesi:</b> <i>Assessment of Factors Affecting Maize Yield in Machakos County</i>	
3.20-3.40	<b>Romano Okwi Elingit, Beatrice Kemunto Obaga:</b> <i>Innovating Agri business Sector for Employment Creations in Busia County</i>	
3.40-4.00	<b>Fuchaka Waswa:</b> <i>Investigating in Agricultural Leadership for Sustainable Food Security Planning in Kenya; Historical Insights from Josephonomics</i>	
4.00-4.20	<b>Kinyua M. Wanjohi:</b> <i>Effects of Tillage, Crop Residue and Inorganic Nitrogen on Crop Yield, Soil Carbon and Nitrogen Dynamics in Embu County, Kenya</i>	
4.30-5.00	<b>HEALTH BREAK</b>	

DAY 2: WEDNESDAY, 18 <sup>TH</sup> APRIL 2018 GROUP SESSIONS		
8:00-9.00	Arrival, Registration and Entertainment	Secretariat
<b>GUEST SPEAKER: Prof. Mary Anyango Abukutsa</b> <b>VENUE: THATHA HALL</b>		
Time	Presenter	In-Charge
9.00-9.30	<b>Prof. Mary Anyango Abukutsa</b> (Deputy Vice-Chancellor, Research, Production and Extension, Jomo Kenyatta University of Agricultural Technology) <i>Harnessing African Indigenous Vegetables for Africa's Sustainable Development</i>	Dr. Wycliffe Amukowa (Chair)-Registrar-RIL, Dr. Cornelius Okello (Rapporteur)
9.30-10.00	<b>Plenary</b>	
10.00-10.20	<b>George Kariuki, Jennifer Njaramba, Charles Ombuki:</b> <i>Climate Change and Maize Yield in Kenya: An Econometric Analysis</i>	Dr. Julius Nzeve (Chair)
10.20-10.40	<b>Audu Sani:</b> <i>Analysis of Rural Poverty in Geidam Local Government Area of Yobe State, Nigeria</i>	Dr. Marther Ngigi (Rapporteur)
10.40-11.00	<b>Olung'ati O. E, Gudu S.O, Ouma E, Ochuodho J:</b> <i>Screening Selected Maize Single Crosses for Tolerance to Low P in Acidic Soils of Bumula and Maseno</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
11.30-11.50	<b>Kosgei, A.J., Gau, P.M., Kimurto, P.K, Danquah, E.Y., Yeboah, M.A., Offei, S.K., Thudi, M and Varshney, R.K:</b> <i>Quantitative trait loci (QTL) for Yield and its Related Traits in Chickpea under Drought Conditions in Kenya</i>	
11.50-12.10	<b>Oimbo L.M, Auma E, NgodeL.:</b> <i>Effects of Weeds in Yield Loss of Beans</i>	
12.10-12.30	<b>Donald Samuel Ijaka Ino:</b> <i>Factors Affecting Adoption of Mobile Phone based Technologies by Women Farmers in Machakos Sub- county, Machakos County, Kenya</i>	
12.30-12.50	<b>Peter Ngugi Kamande:</b> <i>Effect of using Different types of Irrigation Water on the Soil-to-Crop-Transfer Factor in Leafy Vegetables Grown along Peri-Urban Areas of Kiambu County, Kenya</i>	

12.50-1.10	<b>Oyier M. O, Owuoche J.O, Cheruiyot E. and Oyoo M.:</b> <i>Evaluation of Sweet Sorghum (Sorghum bicolor (L.)Moench) Hybrids Using GGE Biplot Analysis in Western Kenya</i>	
1.10-2.00	<b>LUNCH BREAK</b>	
2.00-2.20	<b><u>Mungai Anne Njeri, Sergio Rustichelli Teixeira:</u></b> <i>Making Marketing Orientation Decisions: The Case of Smallholder Farmers in Kenya's Kiambu West District</i>	Dr. George Kariuki (Chair)
2.20-2.40	<b>Mohammed Ibrahim Girei, Josephine Bosede Ayoola &amp; Godwin A. Abu:</b> <i>Factors Influencing the Intensity of Market Participation Among the Cattle Farmers in Adamawa State, Nigeria.</i>	Nancy Chege (Rapporteur)
2.40-3.00	<b>Japhet Kiragu, David Rutere &amp; Johnstone Mwatika:</b> <i>Sypertix<sup>r</sup>IS Efficacious for Use in Tsetse Control in Kenya</i>	
3.00-3.20	<b>Peter O. Bolo:</b> <i>Residue Removal and Sole Application of Inorganic Fertilizers Decrease the Abundance of Nitrogen Mineralizing Bacteria in Tropical Soils of Sub-Saharan Africa</i>	
3.20-3.40	<b>Esther N. Muia:</b> <i>Macro and Micronutrient Intakes in Female Kenyan Adolescent Elite Athletes</i>	
3.40-4.00	<b>Romano O. Elingit &amp; Tom Onyango:</b> <i>Employee Training New Trends and Challenges on Agricultural Institutions performance in Busia County</i>	
4.00-4.20	<b>Dr. Linnet Hamasi:</b> <i>Indigenous Strategic Crops and Trees for Water, Food Security and Conservation of Environment as Mitigation against Climate Change in Kenya: Focus on Vihiga County</i>	
4.20-5.00	<b>HEALTH BREAK</b>	

<b>DAY 3: THURSDAY 19<sup>th</sup> APRIL 2018: CONFERENCE PRESENTATION SESSIONS</b>		
<b>VENUE: THATA HALL</b>		
<b>Time</b>	<b>Title</b>	<b>In-Charge</b>
9.00-9.20	<b>Theobald Frank Theodory:</b> <i>Vulnerability, Adaptation to Climate Change Among Smallholders Farmers in Kagera Region, Tanzania</i>	Dr. Theobald Frank Theodory (Chair)

9.20-9.40	<b>Nomcebo R. Ubisi, Unathi Kolasini and Obert Jiri:</b> <i>Smallholder farmers' Perceptions Towards Climate Change Interventions in Limpopo Province</i>	Cornelius Okello (Rapporteur)
9.40-10.00	<b>Cornelius Okello, Marco Antonellini, Nicolas Greggio, Nina Wambiji:</b> <i>Freshwater Resources Characterization and Vulnerability to Climate Change of the Shela Aquifer in Lamu, Kenya</i>	
10.00-10.20	<b>Peter Kinyae Musyimi:</b> <i>Assessment of Suitability of Adaptation Strategies to Water Scarcity in Makindu Sub-County, Kenya.</i>	
10.20-10.40	<b>Damaris Muthusi, Robert Arasa:</b> <i>Right to Food and Sustainable Livelihoods: A Case of Pastoralist Communities in Isiolo County, Kenya</i>	
10.40-11.00	<b>Paul Otieno Opee, James Obara &amp; Jacob J.J.O Konyang'</b> <i>Influence of Cluster Group Extension Approach on Cotton Production among Smallholder Farmers in Bura Irrigation and Settlement Scheme, Kenya.</i>	
11.00-11.20	<b>Ruth Kundu &amp; Marther Ngigi:</b> <i>Factors Affecting Performance of Agricultural Value Chains: The Case of Small Scale Coffee Marketing in Kangundo</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
11.30-11.50	<b>MG Kariaga, Onamu, R. Wakhungu J. and Were K. Hassan:</b> <i>Reaction of Rice Blast Pyriculariaoryzae CAV. Isolates on a set of improved rice varieties in Western Kenya indicator to presence of pathogenic strains</i>	
11.50-12.10	<b>Daniel MaghanjoMwamidi, Joan Gabriel Renom, Álvaro Fernández-Llamazares, Daniel Burgas, Pablo Domínguez &amp; Mar Cabeza:</b> <i>Contemporary Pastoral commons in East Africa: A case study among the Daasanach Community of Ileret in Marsabit County, North Kenya.</i>	

**SUB-THEME: TRANSFORMATIVE DEVELOPMENT THROUGH LANGUAGE, CULTURE AND COMMUNICATION TECHNOLOGY**

<b>DAY 1: TUESDAY 17<sup>th</sup> APRIL 2018: CONFERENCE PRESENTATION SESSIONS</b>		
<b>VENUE: KOMA HALL</b>		
<b>Time</b>	<b>Title</b>	<b>In-Charge</b>
2.00-2.20	<b>Chipanda Serikal Simon &amp; Hilda Pembe:</b> <i>A complexity of Swahili Pairwise of Verbal Extensions: Algorithmic Approach</i>	Dr. Vifu Makoti (Rapporteur)

2.20-2.40	<b>Binyanya Ruth and M. A Sirengo:</b> <i>Kiswahili na Familia za Mitaani: Nafasi ya kekatika Maendeleo ya Taifa la Kenya</i>	Binyanya Ruth (Rapporteur)
2.40-3.00	<b>Vifu Makoti:</b> <i>Mchangowa Kiswahili Katika Maendeleo Nchini Kenya</i>	
3.00-3.20	<b>John M. Kobia:</b> <i>Itikadiza Kisiasa Katika Vitabu Teule vya Fasihi ya Watoto ya Kiswahili</i>	
3.20-3.40	<b>John Musyoka, Mutua, Gerald Okioma Mogere, Justus Kyalo Muusya:</b> <i>Taswira Yagereza Katika Riwayaya Hainaya Adam Shafi: Uhakikiwaki- Foucault</i>	
3.40-4.00	<b>Health Break and Departure</b>	
4.00-4.20	<b>Ombito Elizabeth Khalili:</b> <i>Uimarishwaj iwa Umaizi Mseto Kupitia Mikakati Shirikishiya Ufundishajiwa Kiswahili</i>	
4.30-5.00	<b>HEALTH BREAK</b>	
<b>DAY 2: WEDNESDAY, 18<sup>TH</sup> APRIL 2018 CONFERENCE PRESENTATION SESSIONS</b> <b>VENUE: KOMA HALL</b>		
8:00-9.00	Arrival, Registration and Entertainment	Secretariat
<b>GUEST SPEAKER: Prof. Mugendi M'Rithaa (Cape Peninsula University of Technology)</b>		
<b>Time</b>	<b>Presenter</b>	<b>In-Charge</b>
9.00-9.30	<b>Mugendi M'Rithaa:</b> <i>An Afrikan Perspective on Socially Conscious Design</i>	Dr. Larry Ndivo (Chair) Ann Mutua (Rapporteur)
9.30-10.00	<b>Plenary</b>	
10.00-10.20	<b>Nicholas Anyuor:</b> <i>Political Unrest: Cause of Terrorist Radicalization in Kenya</i>	
10.20-10.40	<b>Mmbwanga Florence &amp; Everlyne Simiyu:</b> <i>Effect of Culture on Language used in Communication Technology by University students.</i>	
10.40-11.00	<b>Geoffrey Maroko:</b> <i>The Communication Skills Course: What Skills and For Which Future?</i>	
11.00-11.30	<b>HEALTH BREAK</b>	

11.30-11.50	<b>Omolasoye Adesoye:</b> <i>Ofo Genre: Litmus for Yoruba Science and Technology</i>	Dr. Alex Kamwaria (Chair) Florence Mmbwanga (Rapporteur)
11.50-12.10	<b>Nicholus Anyuor &amp; Barasa Asanta Brigit:</b> <i>Role of Vernacular Radio in the Kenya's Devolved Governments (A case of Radio Ramogi in Nyatike sub County, Migori County)</i>	
12.10-12.30	<b>Juliana Achieng Oswago:</b> <i>Use of Computer Assisted English Language Teaching in Private Intermediate Schools in Borama, Somaliland.</i>	
12.30-12.50	<b>Joseph Hokororo Ismail:</b> <i>An Investigation of English Academic Writing errors encountered by Certificate in Law Students in selected Tanzanian Institutions Offering Law Programme</i>	
12.50-1.10	<b>Larry Ndivo:</b> <i>Indigenous Languages as Cultural Repositories: A Case of The Waata and Munyoyaya Communities</i>	
1.00-2.00	<b>LUNCH BREAK</b>	
2.00-2.20	<b>Jane Kieru &amp; Lucy W. Ngige:</b> <i>Socio-Demographic Characteristics and their Influence on Self-Efficacy in HIV Prevention among PLWHA in Kiambu County, Kenya.</i>	Dr. Geoffrey Maroko (Chair)  Dr. Larry Ndivo (Rapporteur)
2.20-2.40	<b>Wanjiru B.N, Koech &amp; Muthiani:</b> <i>Relationship Between Gender and the use of Indigenous Knowledge Systems in Conservation of Nuu Hill Forest.</i>	
2.40-3.00	<b>Jean Pierre Nikuze:</b> <i>After Negative Ethnicity: The of Voting in Kenya</i>	
3.00-3.20	<b>Daniel NjaneThuo &amp; Veronica Nyaga:</b> <i>Students' Knowledge of HIV/AIDS and their Attitude Towards Sexual Behaviour. A Comparative Study of Form 1 and Form 4 Secondary school students in Coast region.</i>	
3.20-3.40	<b>Anderson Mwito, Jane N. Kieru:</b> <i>Influence of Men's perception on contraceptive uptake in Maua Division, Meru county, Kenya</i>	
3.40-4.00	<b>Emmanuel Mutungi:</b> <i>Indigenous Knowledge and Transformative development: Using proverbs and taboos as development reminders in Africa</i>	
4.00-4.20	<b>Emmah Matheka, Mutune Peter:</b> <i>Quality of life and its determinants among people living with HIV/AIDS from Kangundo subcounty Hospital Comprehensive Care Clinic</i>	
4.30-5.00	<b>HEALTH BREAK</b>	
<b>DAY 3: THURSDAY, 19<sup>TH</sup> APRIL, 2018: GROUP A. VENUE: PL5</b>		
9.00-9.20	<b>Everlyne Etakwa-Simiyu &amp; Florence Mmbwanga:</b> <i>The Role of Culture in Communication</i>	Dr. Jane M. Ombati

9.20-9.40	<b>Sophia Njeru:</b> <i>Advancing African Indigenous Sustainable Practices for Transformative Development: The case of Mau Ogiek people, Kenya</i>	(Maasai Mara University) (Chair)
9.40-10.00	<b>Fellis Nthambi Mutune:</b> <i>An Evaluation of the Inaugural speech made by His Excellence the Presidency of Kenya on the 28<sup>th</sup> November 2017</i>	Dr. Alex Kamwaria (Rapporteur)
10.00-10.20	<b>Lilac Osanjo:</b> <i>Development of emblems for Longevity for County Governments in Kenya</i>	
10.20-10.40	<b>Mutawalli Alhaji Sule:</b> <i>Assessment of ECOWAS Free Movement Protocol in Promoting Regional Growth and Development in West Africa</i>	
10.40-11.00	<b>Ibrahim Ghide Adamu:</b> <i>Niger-delta crisis: Its causes and Effects on the Socio-economic life of the People of Ogoni, Rivers state, Nigeria</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
<b>DAY 3: THURSDAY, 19<sup>TH</sup> APRIL, 2018: GROUP B. VENUE: PL2</b>		
9.20-9.40	<b>Geoffrey Maroko:</b> <i>Sustainable Development Goals: Windows of Opportunity for Applied Linguists?</i>	
9.40-10.00	<b>Ann K. Orangi &amp; Millicent Kimemia:</b> <i>Determiners of Demographic Segmentation on Consumer of Choice of Ready to Wear Clothes in Kenya</i>	Dr. Sophia Njeru (Chair)
10.00-10.20	<b>Brenda M. Wambua:</b> <i>Effects of University Students' Use of Social Media Technologies on their Academic Writing</i>	Brenda Wambua (Rapporteur)
10.20-10.40	<b>Colletta Ruth Matayo:</b> <i>Empowering Communities Through Fashion Design; The Case of Ubuntu, MaaiMahiu Kenya</i>	
10.40-11.00	<b>Charles K. Moywaywa:</b> <i>Reconstructing Masculinity through Language, Culture and Communication Technology.</i>	
11.00-11.20	<b>Antony Njeru, Dr. Pamela Muriungi &amp; Dr. John Ngige:</b> <i>Cultural and Religious Factors Hindering Guardians of Children with Clubfoot from Seeking Corrective Services in Embu Clubfoot Care for Kenya Clinic.</i>	
<b>DAY 3: THURSDAY, 19<sup>TH</sup> APRIL, 2018: GROUP C. VENUE: PL3</b>		
9.20-9.40	<b>Jane M. Ombati:</b> <i>A comparison of Descriptive English Compositions of Visually Impaired and Sighted Students in Kenyan Secondary Schools</i>	Dr. Larry Ndivo (Chair)
9.40-10.00	<b>Ong'eta Wycliffe Mose:</b> <i>Culture, Peace and Development: The Case Study of West Pokot County, Kenya</i>	Evelyne Etakwa Simiyu (Rapporteur)
10.00-10.20	<b>Chipanda Serikal Simon:</b> <i>The Proposition for Morph Ordering Elegance in Bantu Languages: The Case of Polymorphic Verbs</i>	
10.20-10.40	<b>Pamela Aliviza Kerre:</b> <i>An Evaluation of the Influence of Culture on Poverty: A Comparative Study of The Bukusu and Kikuyu Communities in Bungoma County, Kenya</i>	

10.40-11.00	<b>Susan Mwangi:</b> <i>The Role of Vernacular Radio Stations in Peace Building and Post-Conflict Reconstruction Initiatives in Kenya</i>	
11.00-11.20	<b>Otieno Millicent Awuor:</b> <i>Gender Information Sources of Communication for Development: A Study of Migori County Government, Kenya.</i>	
<b>DAY 3: THURSDAY, 19<sup>TH</sup> APRIL 2018: GROUP D. VENUE:PL4</b>		
9.20-9.40	<b>Sunday Rhodest Adong and Emmanuel Mutungi:</b> <i>The Old Wine in the New Skin: Integrating Acholi Ritual Pots in Contemporary Space</i>	Dr. Geoffrey Maroko (Chair)  Muktar Ahmed (Rapporteur)
9.40-10.00	<b>Joseph Murithi Jessee:</b> <i>Translated Kiswahili Texts: A Case Study of Kithaka Wamberia's Texts</i>	
10.00-10.20	<b>Mutungi Emmanuel and Arinaitwe Nkiziibweki:</b> <i>Rooted in Culture, Manifested in Contemporary Designs: Developing Bridal Adornments with Designs Inspired by Ankole Motifs</i>	
10.20-10.40	<b>Muktar Ahmed:</b> <i>A Study of Maasai Jewelry and Fulani Textile Material Culture Used in Selected Rites of Passage for Sustainable Development</i>	
10.40-11.00	<b>Paul Kombo:</b> <i>An Inquiry into Youth Innovativeness in radicalization and Extremism: The Case of the Recent Manchester City Bombing and Al-Shabaab Activity in Kenya</i>	
11.00-11.20	<b>Dr. Linnet Hamasi, PhD:</b> <i>Women, Entrepreneurial Market Networks and Development in Kenya: Focus on ElgeyoMarakwet County</i>	

**SUB-THEME: INNOVATIVE APPROACHES TO EDUCATION AND TRAINING FOR SUSTAINABLE DEVELOPMENT**

<b>DAY 1: TUESDAY 17<sup>th</sup> APRIL 2018: CONFERENCE PRESENTATION SESSIONS VENUE: VOI HALL</b>		
<b>Time</b>	<b>PRESENTATION</b>	<b>In-Charge</b>
2.00-2.20	<b>Ndiritu Chiuri:</b> <i>Fostering Distributed Leadership Practices in a Teachers College: Innovative Approach for Increasing Teacher Organizational Commitment</i>	Prof. James Muola  (Chair)
2.20-2.40	<b>Christopher K. Yegon:</b> <i>Innovative Approaches to Education and Training for Sustainable Development</i>	

2.40-3.00	<b>Romano Okwi Elingit:</b> <i>Assessment of Secondary School Students Options Towards Pursuing Agriculture Related Courses at Post-Secondary Institution A Case of Secondary Schools in Teso South Sub County</i>	Dr. Pamela Muriungi (Rapporteur)
3.00-3.20	<b>Dr. Selpher K. Cheloti and Dr. Redempta Maithya:</b> <i>Application of Computer Skills in Teaching and Learning in Kenya; A case of Public Secondary Schools in Machakos Sub-County</i>	
3.20-3.40	<b>Jemimah Muchai:</b> <i>An Investigation into Factors that Contribute to Cheating in Examinations in Technical Institutions in Central Province, Kenya</i>	
3.40-4.00	<b>Malah Kachallah:</b> <i>The Impact of Management Staff Members on Motivation and Student Attainment: A case study of Yobe State Polytechnic, Geidam, Nigeria</i>	
4.00-4.20	<b>Yahya Umar Magaji:</b> <i>Using Path to Determining Parental Involvement on child Academic Performance for Sustainable Development in Nigeria</i>	
4.30-5.00	<b>HEALTH BREAK</b>	
<b>DAY 2: WEDNESDAY, 18<sup>TH</sup> APRIL, 2018</b>		
8:00-9.00	Arrival, Registration and Entertainment	
<b>GUEST SPEAKER: Prof. Donald Kisilu Kombo. VENUE: VOI HALL</b>		
<b>Time</b>	<b>PRESENTATION</b>	<b>In-Charge</b>
9.00-9.30	<b>Prof. Donald Kisilu Kombo:</b> <i>Innovative Domains in Competency Learning: Theories and Models</i>	Prof. James Muola (Chair) Dr. David Mulwa (Rapporteur)
9.30-10.00	<b>Plenary</b>	
10.00-10.20	<b>Joyce Agalo:</b> <i>Preparing Faculty for Utilization of Innovative Approaches in Digitalized Teaching and Learning Environments</i>	
10.20-10.40	<b>Babagana Ali Dapshima:</b> <i>Impact of Supervision on the Management of Secondary School in Maiduguri Metropolitan Council Borno State</i>	
10.40-11.00	<b>Nur Adam Imam:</b> <i>Strengthening the Standard of Biology Teacher in Secondary Schools</i>	

11.00-11.30	<b>HEALTH BREAK</b>	
11.30-11.50	<b>Joshua Kipkorir Cheruyoit:</b> <i>Influence of School Category on Students' Choice of Agriculture Subject in Secondary Schools in Nakuru County, Kenya</i>	
11.50-12.10	<b>Obondo Gaudence:</b> <i>Effects of Hypermedia on Learning Achievement in Geography for Hearing Impaired Learners in Mixed Secondary Schools in Kenya.</i>	
12.10-12.30	<b>Joseph Hokororo Ismail:</b> <i>Assessment and Relevance of English Communication Skills Syllabus of Diploma in Law Programme in Tanzania: Does it Bring Competency Based Education and Training as Expected?</i>	
12.30-12.50	<b>Omari Hassan Kinyua:</b> <i>Transforming Madrasa Education for Sustainable Development</i>	
12.50-1.00	<b>Rose KaindiMueni, Redempta Maithya:</b> <i>Family Size and Boy-Child Drop Out Rate In Public Day Secondary Schools In Makueni County, Kenya</i>	
1.00-2.00	<b>LUNCH BREAK</b>	
2.00-2.20	<b>Wycliffe Amukowa &amp; Sahaya G. Selvam:</b> <i>Implications of Character Strengths for University Education in the Light of Call for Innovation and Entrepreneurship Domains</i>	Katherine Fulgence, Tanzania (Chair)
2.20-2.40	<b>Gilbert Nyakundi Okebiro &amp; Irene Moraa Ongwesa:</b> <i>Innovative Approaches to Higher Education and Training for Sustainable Quality and Standardization of University Education for Sustainable Development in Kenya</i>	Jemimah Muchai (Rapporteur)
2.40-3.00	<b>Muriu Stephen Macharia:</b> <i>Reengineering Mass Careers Through Technical Vocational Education Training in Kenya</i>	
3.00-3.20	<b>Katherine Fulgence:</b> <i>Relevance of Entrepreneurship Education for Teachers and Teacher Curriculum</i>	
3.20-3.40	<b>Oluwasesan Adebuseyi Ojo:</b> <i>Impact of Web-Based Solutions on Student Related Services: Case Study of the University of Maiduguri Borno State, Nigeria.</i>	
3.40-4.00	<b>Titus O. Pacho:</b> <i>Global Citizenship Education and Sustainable Development</i>	
4.30-5.00	<b>HEALTH BREAK</b>	
<b>DAY 3: THURSDAY, 19<sup>TH</sup> APRIL, 2018: GROUP A: VENUE: VOI HALL</b>		
9.00-9.20	<b>Areba George Ngwacho:</b> <i>Management of Co-Curricular Activities and Its Implications in Quality Education in Public Secondary Schools in Kisii County, Kenya</i>	Dr. David Mulwa (Chair)
9.20-9.40	<b>Maurice kibet Kimosop:</b> <i>Empirical Assessment of Demographic Factors Influencing Organizational Commitment in Secondary Schools in Kenya</i>	Dr. Maurice Kimosop (Rapporteur)

9.40-10.00	<b>James Muola and Wycliffe Amukowa:</b> <i>The Virtue of Academic Integrity: Prevalence, Antecedents and Intervention Measures</i>	
10.00-10.20	<b>David M. Mulwa:</b> <i>The Journey Towards Enhanced Quality of Basic Education in Kenya: Challenges and Policy Suggestions</i>	
10.20-10.40	<b>Njiiri Joyce:</b> <i>Effects of learners' Attitude, Gender and School type on English Language Performance: A case study of Thika West District</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
<b>DAY 3: THURSDAY, 19<sup>TH</sup> APRIL 2018: GROUP B: VENUE: MARUBA HALL</b>		
<b>Time</b>	<b>PRESENTATION</b>	<b>In-Charge</b>
9.00-9.20	<b>Mohammed Zannan Malilima:</b> <i>The Impact of Pre-Service Teacher's Awareness of Bio-Entrepreneurial Skills, as a Panacea for Reducing Unemployment among Biology Graduates in Borno State, Nigeria.</i>	Dr. Richard Kimiti (Chair)
9.20-9.40	<b>Orucho M. Ngala:</b> <i>Higher Education Curriculum Orientation and Performance of University in Kenya: Industry Linkages Strategies</i>	Dr. Francis Mutua (Rapporteur)
9.40-10.00	<b>Onyango Daniel Oduor:</b> <i>The Impact of Parents and Community Support on Primary Schools' Pupils Academic Achievement in Siaya and Kisumu Counties, Kenya</i>	
10.00-10.20	<b>Beatrice Abisaki Mbune &amp; Wycliffe Amukowa:</b> <i>Innovation Diffusion in Kenya's Online Examination Registration Practices: Implications and Challenges</i>	
10.20-10.40	<b>Andrew Itodo:</b> <i>The Need for ICT in Adult Education for Socio-Economic Development in Maiduguri, Borno State</i>	
10.40-11.00	<b>Yusuf Bakari:</b> <i>Influence of Cultural Practices on Girl-Child Participation in Secondary School Education in Adamawa State, Nigeria</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
<b>DAY 3 THURSDAY, 19<sup>TH</sup> APRIL 2018: GROUP C. VENUE: KOMA HALL</b>		
9.00-9.20	<b>Josphat Mboya Kiweu:</b> <i>The Relationship between Learning Approaches and Students' Academic Performance</i>	Dr. Pamela Muriungi (Chair)
9.20-9.40	<b>Motanya, Jared Ochwangi:</b> <i>Harnessing Innovative Opportunities in Higher Education towards Achieving Sustainable Development in Africa</i>	Dr. Peter Koech (Rapporteur)
9.40-10.00	<b>Veronica Munanie Mutinda:</b> <i>Preparedness and Attitude of Student Teachers Towards Teaching in Mother Tongue in Kenyan Primary School: Affecting Planning and Material Development</i>	

10.00-10.20	<b>Johannes Njagi Njoka &amp; Mr. Perminus Githui:</b> <i>Harnessing Educational Technology to Stimulate Critical Thinking among Secondary School Learners for Sustainable Development in Kenya</i>	
10.20-10.40	<b>Kimiti Richard Peter &amp; Erick O. Muok:</b> <i>The Doomed Future: An Analysis of the Impact of 'Muguka' Abuse on University Students' Academic Performance: A Case of Machakos And Kitui Counties, Kenya</i>	
10.40-11.00	<b>Jacob JJ Konyango:</b> <i>Challenges to Curriculum Reforms: Secondary School Agriculture in Kenya: 1959-2016</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
<b>DAY 3 THURSDAY, 19<sup>TH</sup> APRIL 2018: GROUP D. VENUE: CONFERENCE ROOM 1</b>		
9.00-9.20	<b>Kang'ara Hannah Wanjiku &amp; Peter Kibet Koech:</b> <i>Influence of Teachers' Instructional Practices: Collaborative Activities in Preschool Teaching and Learning in Kiambu West Sub-County; Kenya.</i>	Dr. Francis Mutua (Chair)
9.20-9.40	<b>Muia L.</b> <i>Towards Sustainable University Education in Kenya</i>	Dr. Johannes Njagi. (Rapporteur)
9.40-10.00	<b>Richard Kimiti &amp; Marieta Mulinge:</b> <i>Moderating the Challenges Faced in the Provision of Laboratory Resources for Science Subjects: A Spotlight Public Secondary Schools in Machakos Sub- County Kenya</i>	
10.00-10.20	<b>Otulo Wandera Cyril:</b> <i>Mean Effects of Service-Learning as an Innovative Approach to Education and Societal Development</i>	
10.40-11.00	<b>Kiamba Elizabeth Welu and Dr. Mutua Francis:</b> <i>Effect of Teacher Preparedness on Academic Achievement of Kiswahili Language in Public Secondary Schools in Kathonzweni Sub-County, Makueni, Kenya</i>	
11.00-11.30	<b>HEALTH BREAK</b>	

**SUB-THEME: BUSINESS AND INNOVATIVE APPROACHES FOR SMALL & MEDIUM ENTERPRISE DEVELOPMENT**

<b>DAY 1: TUESDAY 17<sup>th</sup> APRIL 2018: CONFERENCE PRESENTATION SESSIONS</b>		
<b>VENUE: ILUVYA HALL</b>		
<b>Time</b>	<b>PRESENTATION</b>	<b>In-Charge</b>
2.00-2.20	<b>George Mungiria Muthaa:</b> <i>Effect of Strategic Direction on the Performance of Technical Training Institutions in Meru County, Kenya</i>	PRof. Robert Arasa (Chair)
2.20-2.40	<b>Duncan shirandula and Stella Mwawaza:</b> <i>A Review of Drivers of Technology Adoption and Effects on the Performance of Hospitality Industry in Kenya</i>	Margaret Musyoka

2.40-3.00	<b>Odeny Jane Akinyi and Duncan Shirandula:</b> <i>Role of Supply Chain Management Practices on Environmental in Classified Hotels in Mombasa County, Kenya</i>	(Rapporteur)
3.20-3.40	<b>Agnes Mutiso:</b> <i>Management Commitment and the Extent of Sustainability Reporting Among Companies Listed on Nairobi Securities Exchange in Kenya</i>	
3.40 -4.00	<b>Sylvia N. Kiamba:</b> <i>Improved and Increased Livelihood Options: A Case Study of Skills and Development Training for Youths in Jubba Land, Somalia.</i>	
4.00-4.20	<b>Marcel Maré &amp; Mugendi M’rithaa:</b> <i>Advancing A Clean Cookstove Culture in Sub-Saharan Africa: The Transformative Power of Afrikan Innovation</i>	
4.30-5.00	<b>TEA BREAK</b>	
<b>DAY 2: WEDNESDAY, 18<sup>TH</sup> APRIL 2018: VENUE: ILUVYA HALL</b>		
8:00-9.00	Arrival, Registration and Entertainment	Secretariat
<b>GUEST SPEAKER: Prof. SimmyMarwa (Dedan Kimathi University of Technology)</b>		
9.00-9.30	<b>Prof. SimmyMarwa</b> <i>Business and Innovative Approaches for Small &amp;Medium Enterprise Development</i>	Prof. Charles Ombuki Dr.Jacinta Kinyili (Rapporteur)
9.30-10.00	<b>Plenary</b>	
10.00-10.20	<b>Sedina Misango:</b> <i>Does Innovative use of Social Media Training Enhance Business Growth? A Case of Subira Self Help Group, Nairobi</i>	
10.20-10.40	<b>Dominic Njue, Benson Kipkemboi Kenduiywo:</b> <i>Geospatial Technologies for Sustainable Development</i>	
10.40-11.00	<b>Nyalita Angela Mwikali:</b> <i>Family Business Succession Planning, Entrepreneurial Orientation and Firm Performance among Small and Medium Enterprises</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
11.30-11.50	<b>Hammanjoda, Kabiru:</b> <i>Service Quality Delivery and Customers’ Satisfaction in Nigeria Banking Industry</i>	Prof. Robert Arasa (Chair) Margaret Musyoka (Rapporteur)
11.50-12.10	<b>James N Ndegwa:</b> <i>Determinants of Property Prices in Gated Communities in Nairobi City of Kenya</i>	
12.10-12.30	<b>Josephat Mboya Kiweu:</b> <i>Mergers and Acquisitions in the Kenyan Banking Sector: Do Shareholders Stand to Benefit?</i>	
12.30-12.50	<b>Miriti Jane Kinya&amp; Augustine Maswili:</b> <i>Financing Models for Upgrading Mango Value Chain in Kenya. A Case Study</i>	

	<i>of Eastern Province.</i>	
12.50-1.00	<b>Pollyne Mbithe Mutunga:</b> <i>Impact of Women Groups Table Banking Initiative on The Socio-Economic Status of Households in Machakos County.</i>	
1.00-2.00	<b>LUNCH BREAK</b>	
2.00-2.20	<b>Muiya, M. K:</b> <i>Sustainable Design approaches for Handicraft Community Development in Machakos County.</i>	Dr. Nyalita Angela Mwikali (Chair)  Evans Mogeni (Rapporteur)
2.20-2.40	<b>Rahab Karari:</b> <i>Entrepreneurship Education and Eco-Preneurship Innovations as Change Agents for Environmental Problems</i>	
2.40-3.00	<b>Salome Musau, Stephen Muathe &amp; Lucy Mwangi:</b> <i>Financial Inclusion and Stability of Commercial Banks in Kenya: Synergies and Trade-offs</i>	
3.00-3.20	<b>Joy Minyenya:</b> <i>Secrets to Success in Informal Sector Financial Compliance: Utilizing New Technological Applications for Improved Community Health Program Efficiency and Effectiveness</i>	
3.20-3.40	<b>Mercy Wanjiku Wambui:</b> <i>Assessing Factors Influencing Adoption of Livestock Insurance by Dairy Farmers in Githunguri, Kiambu County.</i>	
3.40-4.00	<b>Mosoti Cynthia Kerubo:</b> <i>Factors Affecting Marketing of Broilers by Small Scale Farmers in Nairobi County</i>	
4.00-4.20	<b>Paulson Letsholo, Richie Moalosi &amp; Olefile B. Molwane:</b> <i>Developing the Furniture Design and Manufacture industry in Botswana – A Design Thinking approach</i>	
4.30-5.00	<b>HEALTH BREAK</b>	
<b>DAY 3: THURSDAY 19<sup>TH</sup> APRIL, 2018. VENUE: ILUVYA HALL</b>		
<b>Time</b>	<b>PRESENTATION</b>	<b>In-Charge</b>
9.00-9:20	<b>Falusi Olamide:</b> <i>Nigerian Plant Resources, An Incredible Generosity with an Incredible Responsibility</i>	Prof. Josephat Kiweu (Chair)  Evans Mogeini (Rapporteur)
9.20-9.40	<b>Gichunge C, Mutiso D:</b> <i>Predictors of Social Support, Physical and Mental Health among Food Insecure Internally Displaced Persons in Turkana, Kenya</i>	
9.40-10.00	<b>Jacob Gichimu, Mary Adam, Fanice Nyatigo:</b> <i>A Social; Enterprise for better Maternal Health Services through Mobile Messages Automated-System, A Pilot Study in AIC Kijabe Hospital, Kiambu County</i>	
10.00-10.20	<b>Sangoro Oscar:</b> <i>MFI Financial Sustainability on the Realization of Economic Pillar of Vision 20130: A Case of Kakamega County</i>	
10.20-10.40	<b>Donald Samuel Ijaka:</b> <i>Factors Affecting Adoption of Mobile Phone Based Technologies by Women Farmers in Machakos Sub-county, Machakos County, Kenya</i>	

10.40-11.00	<b>Lydia Nanjala, Muganda Munir Manini and Umulkher Ali Abdillahi:</b> <i>Accounting control Practices and Financial Performance of Small and Medium Enterprises in Eldoret Town, Kenya</i>	
11.00-11.20	<b>Dr. Jacinta M. Kinyili:</b> <i>Role of Remuneration Practices on the Retention of Employees in Public Health Institutions in Machakos County, Kenya</i>	
11.00-11.30	<b>HEALTH BREAK</b>	

**SUB-THEME: SCIENCE, TECHNOLOGY, ENGINEERING, MATHEMATICS AND INNOVATION FOR INDUSTRIAL TRANSFORMATION**

<b>DAY 1: TUESDAY 17<sup>th</sup> APRIL 2018: CONFERENCE PRESENTATION SESSIONS</b>		
<b>VENUE: KILIMAMBOGO HALL</b>		
<b>Time</b>	<b>PRESENTATION</b>	<b>In-Charge</b>
2.00-2.20	<b>Stephen Mailu:</b> <i>Electrochemical Determination of Highly Carcinogenic Hydrazine in Waste water</i>	Dr. Veronica Okello (Chair)  Dr. Elizabeth Ndunda (Rapporteur)
2.20-2.40	<b>Otieno Kevin Okoth:</b> <i>Facile Fabrication of an Ultrasensitive PEC Aptasensor for Diclofenac based on Graphene-Doped Cds And Gold Nanoparticles</i>	
2.40-3.00	<b>C.O. Muga, W. Zhang:</b> <i>Effects of Thermos- Mechanical Treatments on Mg-14Li-3Al-3Ce Quarternary Alloy</i>	
3.00-3.20	<b>Mary A. Opiyo, James Jumbe, Charles C. Ngugi, Harrison Charo- Karisa:</b> <i>Effects of Different Levels of Commercial Probiotics on Growth Performance, Survival and Carcass Composition of Nile Tilapia Reared in Cages in Low Input Ponds</i>	
3.20-3.40	<b>Domitila Kyule- Muendo, Simon W. Mburu, Antony Kebira Nyamache, Ezekiel Mugendi Njeru, John Mwangi:</b> <i>Knowledge and Perceptions of Fish Handlers on Risk Factors Associated with Contamination and Spillage of Fish and Fish Products in Kirinyaga County</i>	
3.40- 4.00	<b>Japhet Kiragu, Peter Wagate, David Rutere:</b> <i>Revised Protocol for the Evaluation of the Efficacy of Insect Pest Control Products using Bioassays in Kenya</i>	
4.00-4.20	<b>Julius Kioko Nzeve, Esther Chepkoech Kitur &amp; Steven Gichuki Njuguna:</b> <i>Bioaccumulation of Heavy Metals in Common Carp (Cyprinus Carpio) from Masinga dam, Kenya</i>	

4.30-5.00	<b>HEALTH BREAK</b>	
<b>DAY 2: WEDNESDAY, 18<sup>TH</sup> APRIL, 2018. VENUE: KILIMAMBOGO HALL</b>		
8:00-9.00	Arrival, Registration and Entertainment	Secretariat
<b>GUEST SPEAKER: Prof. Birhanu. F.Dejene (Free Town State University- South Africa)</b>		
9.00-9.30	<b>Prof. Birhanu F. Dejene:</b> <i>Green Energy Sources as Solutions for Sustainable Energy for The Past, Present and Future through Community Engagement</i>	Dr. Charles Mwaniki (Chair)
9.30-10.00	<b>Plenary</b>	Dr. David Wekesa (Rapporteur)
<b>DAY 2: WEDNESDAY, 19<sup>TH</sup> APRIL 2018: GROUP A. VENUE: KILIMAMBOGO HALL</b>		
<b>Time</b>	<b>PRESENTATION</b>	<b>In-Charge</b>
10.00-10.20	<b>Suleman Nasiru, Peter N. Mwita, Oscar Ngesa:</b> <i>Exponentiated Generalized Geometric Burr Iii Distribution</i>	Dr. Mark Kimathi (Chair)
10.20-10.40	<b>Martin M. Kasina:</b> <i>Modelling the Plurotusostreatus Optimum Production Using Simplex Centroid Design</i>	Dr.Euna Nyarige (Rapporteur)
10.40-11.00	<b>Chamuchi N.M., Johana K. Sigey, Kang’ethe G.:</b> <i>Mathematical Modelling and Analysis of HIV/AIDS and Transmission Dynamics Influenced by Public Health Education Campaign</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
11.30-11.50	<b>Cyprian Omari, Peter Mwita&amp; Antony Waititu:</b> <i>Estimating Portfolio Risk using GARCH-EVT-Copula Model: An Empirical Study on Currency Exchange Rate Market</i>	Dr. Mark Kimathi (Chair) Dr.Euna Nyarige (Rapporteur)
11.50-12.10	<b>Euna Gesare Nyarige, Jürgen Franke and Alexander Fischer:</b> <i>On Changepoint Detection in a Series of Stimulus-Response Data</i>	
12.10-12.30	<b>Irene W. Irungu, Peter N. Mwita &amp; Antony G. Waititu:</b> <i>Consistency of the Manhattan Distance for Model Order Change-Point Detection in Garch Models</i>	
12.30-12.50	<b>Kenfac Dongmezo Paul Brice, Peter N. Mwita &amp; KamgaTchwaket Ignace Roger:</b> <i>Performance of Imputation Methods towards Increasing Percentage of Missing Values</i>	
12.50-1.10	<b>Victor Kemboi Tomno:</b> <i>The Weakly Sign Symmetric Po Matrix Completion Problem for Patterns of Digraphs of Order Two and Three</i>	
1.00-2.00	<b>LUNCH BREAK</b>	
2.00-2.20	<b>Ephraim Motaroki Menge, Ezekiel Mugendi Njeru &amp;</b>	Dr. Japhet Kiragu

	<b>John Maingi:</b> <i>Does Rhizobial Inoculation Functionality Vary with Host Plant Genotype? A Case Study of Common Bean Phaseolus Vulgaris L. Germplasms Grown by Smallholder Farmers in Eastern Kenya.</i>	(Chair) Ruth Wanjiru (Rapporteur)
2.20-2.40	<b>Ruth Wanjiru Mwangi &amp; Coletta Ruth Matayo:</b> <i>Ecological Design of Recreation Centres for Environmental Conservation</i>	
2.40-3.00	<b>Alhaji Attahir Husseini:</b> <i>Innovative Approaches for Climate Change Mitigation in Transport institutions in Nigeria</i>	
3.00-3.20	<b>Stephano Adrian Karoza, Dedi Jusadi and Mohammad Agus Suprayudi:</b> <i>Utilization of Duckweed (Lemna minor) Meal for the Replacement of Soybean Meal in the Diet of Nile Tilapia (Oreochromis Niloticus)</i>	
3.20-3.40	<b>Francis K. Musyoka and Raphael M. Wambua:</b> <i>Effect of Streamflow on Hydro-power Generation in the Upper Tana River Basin, Kenya</i>	
3.40-4.00	<b>Samuel Namu, Hannah Karuri &amp; Editah Njeri:</b> <i>Population Dynamics and Infestation Level of Root Knot Nematodes in Rainfed Upland and Irrigated Lowland Rice Cropping Systems in Kenya</i>	
<b>DAY 2: WEDNESDAY, 18<sup>TH</sup> APRIL 2018 GROUP B: VENUE: SEMINAR ROOM 2</b>		
<b>Time</b>	<b>PRESENTATION</b>	<b>In-Charge</b>
10.00-10.20	<b>David Wafula Wekesa, Kelvin Lodenyi &amp; Joseph Kamau:</b> <i>An Understanding of Turbulence in the Atmospheric Boundary Layer</i>	Dr. Stephen Mailu (Chair) Dr. Elizabeth Ndunda (Rapporteur)
10.20-10.40	<b>Grandawa M. M:</b> <i>Wastewater Disinfection by Titanium Dioxide (TiO<sub>2</sub>) Solar Photocatalysis</i>	
10.40-11.00	<b>Elizabeth Ndunda:</b> <i>Molecularly Imprinting: Promises and Challenges</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
11.30-11.50	<b>D. A. Tonga:</b> <i>Path Loss Propagation Model Prediction for GSM Mobile Networks in Nigeria</i>	

11.50-12.10	<b>Charles Mwaniki &amp; Robert Joshua:</b> <i>Energy audit: A case study</i>	
12.10-12.30	<b>Mohammed Ahmad Abba Kaka &amp; Abdullateef Baba:</b> <i>Effective Utilization of OcimumTenuiflorumin Tropical Environment for Therapy and Reinforce the Importance of Eno-Botanical Approach as Potential Source of Bioactive Substances.</i>	
12.30-12.50	<b>Zannah Alhaji Ali, Ibrahim Ahmed, Hassan Laminu:</b> <i>Toward Industrialized Building System (IBS) Implementation in the Nigerian Construction Industry</i>	
12.50-1.10	<b>Christine N. Mutoro, Johnson Kinyua, Joseph Ng'ang'a, Daniel Kariuki, Johnson M. Ingonga, &amp; Chris O. Anjili:</b> <i>Combination therapy of Leishmania major infection using crude extracts of Solanum nigrum and Plumbago capensis</i>	
1.00-2.00	<b>LUNCH BREAK</b>	
2.00-2.20	<b>Nozipho Zungu, Dr Annette Vanonselen, Prof Unathi Kolanisi &amp; Muthulisi Siwela:</b> <i>Assessing the Nutritional Quality and Consumer Acceptability of Moringa Oleifera Leaf Powder (MOLP)-Based Snacks for Improved Children's Food and Nutrition Security</i>	Dr. Dr. Esther Nduku (Chair)
2.20-2.40	<b>Mugira E. K:</b> <i>Impacts of Intellectual Property Rights in Technology Advancements</i>	Dr. Patricia Mwendu (Rapporteur)
3.20-3.40	<b>TP Kheswa, Dr CJ Du Preez:</b> <i>Undergraduate Food Product Innovation at University of Zululand: Shaping the Future</i>	
3.40-4.00	<b>Garba, G.J., Manga, S. S, &amp;Elizabeth, A, D.:</b> <i>Physicochemical and Bacteriological Analyses of Borehole Water in Kebbi State University of Science &amp; Technology Aliero (Ksusta), Kebbi State, North-Western Nigeria</i>	
4.00-4.20	<b>Isah, M. &amp;Manga, S. S.:</b> <i>Determination of Antibacterial Activity of Acacia Nilotica Wild. Acetone Extract Against Selected Multidrug Resistant Bacteria of Clinical</i>	
4.30-5.00	<b>HEALTH BREAK</b>	
<b>DAY 3: THURSDAY, 19<sup>TH</sup> APRIL 2018: GROUP A. VENUE: SEMINAR ROOM 1</b>		

9.00-9.20	<b>Hassan, L., Alhaji Attahir, H. &amp; Zannah Alh, A.:</b> <i>Effect of Fly Ash and Super plasticiser on the Hardening Properties of Self compacting concrete</i>	<b>Dr. George Waswa</b> (Chair) Benson Wangombe (Rapporteur)
9.20-9.40	<b>Adwek George, Shen Boxiong, Jiancheng Yang, Wang Jianqiao &amp; Cicilia Kemunto:</b> <i>Non-thermal plasma catalytic conversion of nitrogen oxide with CeO<sub>2</sub>/TiO<sub>2</sub></i>	
9.40-10.00	<b>Waswa G.W, Makhanu S.K &amp; Lorentz S.A:</b> <i>Hydrological Analyses of Intense-Rainfall Induced Shallow Landslides</i>	
10.00-10.20	<b>Jomy Joseph:</b> <i>For seeing regenerative futures: VR as a future foresight tool for industrial design</i>	
10.20-10.40	<b>William K. Ndungu &amp; Mark Kimathi:</b> <i>Effects of vehicles lane change manoeuvre on traffic breakdown and congestion in highways</i>	
10.40-11.00	<b>Waswa G.W&amp; Lorentz S.A:</b> <i>A Pressure Wave Theory for a Transient Drawdown in an Unconfined Aquifer</i>	
11.00-11.30	<b>HEALTH BREAK</b>	
<b>DAY 3: THURSDAY, 19<sup>TH</sup> APRIL 2018: GROUP B: VENUE: SEMINAR ROOM 2</b>		
<b>Time</b>	<b>PRESENTATION</b>	<b>In-Charge</b>
9.00-9.20	<b>Moses Ong'au Fred, Johana K. Sigey, Jeconiah A. Okelo:</b> <i>Mathematical Modeling of Delayed Pulse Vaccination of Infectious Diseases</i>	<b>Dr. Charles Muli</b> (Chair) <b>Mr. Martin Kasina</b> (Rapporteur)
9.20-9.40	<b>Ngesa Joel Ochola:</b> <i>Heat and Mass Transfer Past a Semi-Infinite Vertical Porous Plate in MHD Flows in Turbulent Boundary layer.</i>	
9.40-10.00	<b>Muthiga Samuel Ng'ang'a, Prof. Kinyanjui M. N., Dr. Roy Kiogora:</b> <i>Hydromagnetic Fluid Flow Past a Rotating Semi-Infinite Vertical Plate Considering Joule Heating</i>	
10.00-10.40	<b>Charles Muli:</b> <i>Signal Processing Via Mathematical Model using Fourier Transforms and Least Square Optimization Function.</i>	
10.40-11.00	<b>Umar Iiyasu, Muzzakkir M. Adamu:</b> <i>Integration of Photovoltaic Energy with Grid Distribution System</i>	
11.00-11.30	<b>HEALTH BREAK</b>	

## CLOSING CEREMONY: VENUE: KILIMAMBOGO HALL

Time	DAY 3: THURSDAY 19 <sup>th</sup> APRIL 2018	In-charge
11:30-12.00	Assembling and Arrival of Chief Guest	
12.00-1.00	<b>OFFICIAL CLOSING PROGRAMME</b>	
	<ul style="list-style-type: none"> <li>❖ Remarks from Chair of the Conference Dr. Geoffrey Maroko</li> <li>❖ Closing Remarks by <b>Prof. Peter Mwita</b> (DVC-Research, Innovation and Linkages, Machakos University)</li> </ul>	Secretariat
	❖ Closing Address, <b>Prof. Lucy Irungu</b> (Vice-Chancellor, Machakos University)	
	<b>SPEECH AND OFFICIAL CLOSING OF THE CONFERENCE BY H.E. HON. GOVERNOR DR. ALFRED MUTUA, GOVERNOR OF MACHAKOS COUNTY</b>	
	<b>PHOTO SESSION</b>	
<b>1.00-2.00</b>	<b>Lunch Break</b>	
<b>2.00-5.00</b>	<b>Optional Trip to Silicon Savannah</b>	Dr. Larry Ndivo

# **Sub-Theme: Agriculture, Food Security, and Agribusiness for Community Transformation**

**Secondary School Agriculture Curriculum Reforms in Kenya 1959-2016:**

**Challenges to Innovations:**

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## **ABSTRACT**

Fifty seven of curriculum reforms targeting innovations to education through school agriculture remain unattainable to date. Observations indicate challenges to reforms rather progress as there exists a gap between the desired and the reality, the demand for quality and the relevance of what is implemented. The target population for the study included individuals and institutions with both primary and secondary information on innovative strategies on school agriculture. The study used qualitative research with historical design to purposively sample respondents from 26 secondary schools with an initial population of 104 respondents where innovative strategies on school agriculture were implemented. Self-administered interview schedules, visits to school and education offices archives for documentary sources were used to collect data. The data was synthesized and analyzed qualitatively by generating an account of curriculum innovative approaches. This involved selecting, organizing and analyzing the collected data in to topical themes and central ideas and concepts. The findings of this study shows that the perceived reforms either stagnated or were reversed leading to a knowledge and skills gap making the consumers of the curriculum less competitive in the economyof the country. The lessons learnt in this study may help design worthwhile approaches for curriculum reforms with an increased drive for skills and knowledge in producing graduates who are destined to the world of work. The paper recommends the need to establish policy monitoring and implementation machinery to ensure that policies are interpreted and implemented as recommended.

**Key words:** Kenya, reforms, skills, curriculum, strategies, resources.

## **Introduction**

Curriculum reform refers to the need with the purpose of improving and creating relevance in education. Relevancy in education leads attainment of sustainable livelihoods. The world-wide desire for innovative curriculum remains the goal for educational planners. In Kenya the realization of curriculum reforms targeting school agriculture remains elusive. The drive to introduce school agriculture has been based in the belief that the strategy would improve access and at the same time respond to the needs of quality and relevance in education. The Kenya vocational agriculture programme in which resources and facilities are provided to spur reforms in the teaching of the subject dates back to 1959 (Jago & Tanner, 1999; Maxwell, 1965) when agriculture was first introduced in the Secondary School curriculum. The subject targeted rural schools, and according to World Bank (2014), ensuring access and quality must be intensified for the vast rural population who are generally excluded by poverty, ethnicity, gender and other social stigmas. Skills and knowledge acquired in school agriculture is essential in promoting increased farm production through the systematic adoption of new technology and agricultural research findings (Lewa & Ndung'u, 2012). The drive has been guided by the long established mission of agricultural education which emphasizes the scientific study of agriculture targeting the inclusion of the farming community; to dissemination of results of research to a large category of farmers for increased and sustainable agricultural production (Acker & Grieshop, 2004).

Despite the efforts to create innovative strategies in school agriculture for rural transformation between 1959 and 2016 the policies for implementation especially on resources and facilities took a back seat as early as the 1970s as the subject effectively assumed theoretical teaching. Whereas school agriculture in Kenya traces its origin to the US Vocational Agriculture Acts such as the National Vocational Education Act of 1963, (Soretire 1968; FAO/ILO/Ministry of Agriculture 2007) secondary school agriculture in Kenya has remained a hope and wishes tucked in education policy documents gathering dust in shelves. An analysis of the foundation objectives of school agriculture EAEC (1969) shows that the innovative driven objectives would have led to

reforms and innovations in agriculture which would have narrowed the knowledge gap between the subject matter and skills required in economic undertakings.

## **Literature Review.**

### *Curriculum Reforms through School Agriculture*

Relevant literature reviewed in this study indicates that Kenya has had a long history of innovative ideas on school agriculture. As early as between 1928 and 1933, recommendations of the Organization of Agricultural Education for Africans and of the Directors of Education in the then three East African countries: Kenya, Uganda and Tanzania were that; agriculture be made a compulsory and examinable subject and that the practical work in the individual demonstration plots be graded equally with theory (King, 1971; Soretire, 1968). It is significant to realize that whereas these recommendations were made over eighty five years ago, there is lack of data to confirm the implementation reality on the contrary practical agriculture in schools has declined significantly.

On the other hand, the recommendation was an reform touching on assessment. In an effort to implement reforms, the nature of examinations and evaluation is paramount. (UN, 2007; World Bank, 2014) re-iterates that examinations are powerful tools influencing and shaping the school curriculum. Curriculum reform requires good assessment tools which guides policymakers in making effective decisions for evaluating the cost effectiveness of a reformed curriculum. The demand for a purely academic education by Kenyans has remained high going back to colonial period up to this period of time stifling reform strategies (Sifuna, 2001; Bennell, 2007) and this has stifled innovative approaches for vocational and practical oriented subjects.

There is need to understand the nature of the society in which the curricular is provided, this is essential as it will enable adjustments to the reforms with respect to agriculture and education and for sustainability. Curriculum reforms according to (Akoojee & McGraths, 2005; Koulaouzides, Vergos, Acker & Crunkilton, 2003) cannot ignore to ensure that young people are acquiring skills and knowledge that they may need to serve as facilitators to economic progress and reduction of absolute rural poverty. The immediate

consumers of any curriculum reform are the learners and the implementer who is the teacher. There is as (Stewart, Moore Flowers, 2003; Acker & Grieshop, 2004) points out, the need to establish what the current and possible future learner needs in order to have successful careers after completing an education program. There is need to identify reform approaches which may address the apparent challenges to agriculture curriculum reforms which may lead to greater investment in agriculture and a move towards sustainable rural livelihoods and by elimination of global hunger and malnutrition.

Successive reports (World Bank, 2014; UN, 2007 & UNSECO, 2012) all emphasizes that the benefits of an innovative curriculum include provision of opportunities for life by opening-up avenues for acquiring employable skills by the youth leading to decent work and which enables them to climb out of poverty. Sustainable innovative vocational and practical education relies heavily on what goes into it in the first place, ideas, technology, people and financial resources and these must be tied to time available. Making schooling more useful (Akoojee & McGraths, 2005; Koulaouzides, Vergos, Acker & Crunkilton, 2003; Bennell, 2007) has been a major concern for vocational and practical curriculum reform movers and educational planner's worldwide. Experiences from Ghana show the need for appreciation to the value of transferable skills which includes problem solving, effective communication of ideas, creativity and demonstration of entrepreneurial capabilities which a reformed curriculum could provide (FAO/ILO/Ministry of Agriculture, 2007).

### ***Challenges to Curriculum Innovations***

The (King & Martin, 2002; UNESCO, 2012) on the other hand points out at the failure of advances to scientific and technological reforms in agriculture in addressing the needs of small scale farmer in developing countries a factor which agricultural curriculum innovators have similarly neglected. This could be due to observations which show that the position, structure and the activities of the political leadership and policy makers favours academic education which is seen as leading to greater prosperity and power. Indications from relevant literature show that agriculture in the school curriculum has been perceived as second class education unlikely to lead to modern sector employment making any reforms on the curriculum inconsequential. Analysts tend to show that there

has been no meaningful approach to re-orientate the direction of education from purely academic to embrace vocational education, but reality has it that the subject has been merely added to the curriculum without change in philosophy. This is based on the fact that the establishment of school agriculture was not internalized by the rural communities as a desire to improve their lot of living standards. It has continued to reflect its introduction by foreigners in the colonial period, religious groups in which it facilitated the exit of a few gifted rural youth to more prestigious clerical jobs and other white collar jobs ( Sifuna,2001;UNESCO,2012)

### ***Innovative Challenges in the 8-4-4 System of Education.***

The drive for innovative curriculum was the flagship in reforming the school agriculture in the 8-4-4 system of education in 1984 (GoK, 1984). The 8-4-4 system of education approach aimed to reflect the philosophy of experiential education (Brunner, 1996 & Bird, 2002). This new initiative was to revamp the Kenya Vocational Agriculture programme launched between 1959 -67, and which had been expanded to 135 schools by 1984 (GoK, 1984; Maxwell,1965; Onyango, 1975). It was believed that the practical and vocational curriculum approach would ensure that the students graduating at different levels of education would have been equipped with scientific and practical skills essential for self and salary employment or higher levels of education.

Despite the noble 8-4-4 approach to practical and work oriented curriculum, reality has it that the innovative ideas remained still-born as theoretical teaching and aspirations to academic certificates at the expense on skills, attitudes and values which can enrich community development remains buried. There is need to move away from what both Brunner (1996) and Bird (2002) rightly points out that a purely academic education in Africa is still perceived as the major determining factor for social mobility and that it is only through this type of education that an individual can achieve higher occupational enhancement, high income, higher status and higher prestige. This perception according to (Onyango,1975), can be traced to colonial era in which the peasant or the children of the poor were to remain attached to the land and with practical oriented curriculum, and that their education should fit them for that status in life.

The above is also reinforced by the deep-rooted and quiet negative attitude to vocational subjects by teachers, parents and students who continue to view practical subjects as inferior form of education and in such circumstances the provision of resources and facilities is in effect inconsequential. Indications from schools through occasional visits show that despite the existence of agriculture teaching facilities, the schools have adopted the “chalk and talk” teaching strategy which in the views of (Stewart, Moore & Flowers, 2004; King & Martin, 2002) does not relate to ask for reforms in education.

### ***Curriculum Reforms and the Teacher***

Innovative curriculum demands creativity in teaching and must be linked to the training of agriculture teacher. Innovative teachers Dewey and Dewey (1915) promote learner centered approach that awakens the psychology of the educator to plan for the needs of students in relation to the use of resources. This is a strategy for learning by doing in which the learners must be active participants in educational encounter. Where stagnation to reform emerges there must be a review of the strategy and the teacher must be able to engage in teachable methods with the ultimate goal of assisting learners to be intrinsically motivated to be innovators.

It is noteworthy to say that reforms are usually promoted by teachers who are thinkers (Acker & Grieshop, 2004) and whose desires are to address the societal ills or promote societal changes, most often through creation of ideas and knowledge creation as opposed to knowledge consumers. Similarly the views from (UN, 2007 & UNESCO, 2012) shows that reforms and innovations require teachers to look for new ideas and new ways of delivery of content and programs. The speed at which technology and knowledge is advancing requires teachers to prepare students to adopt with change. Helping the learner to deal with change is a strategy of ensuring sustainable reforms in the curriculum. A view shared by reports (World Bank, 2014 & FAO/ILO 2007) expresses the view that to ensure a sustainable innovative agricultural education programme, there is a need to attract and keep high quality teachers. To achieve this, teachers would need the support from stakeholders to help them keep pace with changes in teaching technology, and methodology and technical knowledge in agriculture.

This paper presents an analysis of innovative approaches to school agriculture in the secondary school curriculum. The paper further sought to establish and analyze the relevancy of resources and facilities provided for teaching agriculture over the study period and their implications to curriculum reforms. Practical based learning reinforces problem solving and inquiry-based teaching and learning which breeds reforms. The literature reviewed shows that an approach where the curriculum is backed by relevant resources, the students see learning as interesting and meaningful and this can be one way of addressing the negative perception in school agriculture (Griffiths, 1968; King & Martin, 2002), gets the reforms breeding further reforms and not reversals to creativity.

### ***Theoretical Framework***

This paper has investigated, examined and analyzed the approaches to the implementation of school agriculture curriculum within the context of relevancy to the societal goals and aspirations (Dewey & Dewey, 1915; Haralambos & Heald, 1980). An approach to provide resources and facilities relating to the syllabuses and curricula was a response to the functionalist theory of the French sociologist Emile Durkheim (Haralambos & Heald, 1980) which sees education as the transmission of the society's norms, values and skills.

### ***Methodology***

This study adopted a largely qualitative approach of historical design. It used the systematic nature of historical studies by interviews, documentation of past records from schools, education offices and archives to research for facts relating to approaches to curriculum reforms. These were described, analyzed and interpreted with reference to their impact on curriculum reforms. The study further searched for information relating to provision of resources and facilities relevant to secondary schools with a view for creativity and reforms in teaching. The study adopted a variety of foci that historical research uses such as; issues, movements, concepts, approaches, theories and development (Smit, 2003 & Wiersma, 1995). The historical research in this study contributed in covering a broad area which led to the understanding on approaches to curriculum reform strategies. The study, (Keppel, 1991) involved un-obtrusive methods

that investigated the process and occurrences at different times and in different places. It involved data collection through interviews to the actual participants who were involved in designing the approaches touching various aspects of curriculum reforms. The individuals interviewed for information included former and current agriculture teachers who taught and were believed to have been key to Agriculture curriculum implementation, the current and former head teachers who in their roles sourced for the resources and facilities and who were the implementers of the curricula policies at the school level. The study further targeted the archives, actual sites where the resources were provided, libraries, diaries, government plans, newspapers and official curricula and reports relating to the resources and facilities provision and use. The study purposively sampled 26 secondary schools in which agriculture was taught over the study period, the schools represented a select category of the population with specific data requirements.

## **Results and Discussions**

A review of the related literature identified several approaches including education commission recommendations and agreements dating back to the colonial period which had linkages to syllabuses, curricula, resources and facilities for teaching agriculture. An analysis of different reports and recommendations, visits to schools and workshops involving a wide category of Stake-Holders revealed varied approaches to reform the education by including agriculture in the school curriculum.

### ***a) Secondary School Agriculture as Curriculum Reform Initiative.***

The drive for curriculum reform through school agriculture in Kenya goes back traced to 1959 at Chavakali High School in the current Vihiga County-Kenya. The objective of the strategy included making rural secondary schools more responsive to the needs of society. The strategy was promoting the subject so that all people will value and understand the vital role of agriculture in the society.

The findings of this study shows that Kenya vocational agriculture policy which covered the period between 1959 to 1971 and which included the Chavakali High School, the USAID and IDA projects, set the direction for innovative teaching of

school agriculture. The Chavakali Vocational Agricultural Programme project was supported by a clear syllabus approved by the Government of Kenya, Cambridge Examinations Syndicate and the 1969 East African Examinations Council syllabus. The programme had support through defined identifiable resources, equipment and other facilities which were considered relevant for the implementation of the curriculum. The syllabus shows the content and other strategies like the project work, field visits and extra activities, which were considered essential for vocational agriculture.

However this study shows that there was lack of relationship of resources and the objectives, a key element in curriculum implementation. In the absence of syllabus objectives, it becomes difficult for the teacher to implement the syllabus as it is not easy to pick the relevant resources, and facilities. However, the syllabus was quite detailed in content. It had adequate coverage in skills acquisition which required measurable objectives. A key component of the curriculum was its connections to the stakeholders in the agricultural industry through student field attachment and teacher visits to the community farmers to offer technical advice.

This study has established that for school agriculture to promote reforms in agricultural sector there must be a linkage with the community in the absence of this the needs of the agricultural industry will not be reflected in the implementation. Further findings relating to curriculum implementation were revealed through the samples of examination items from the examining bodies, the East Africa Examinations Council, and the Kenya National Examinations Council over the study period which reveals that although these resources and facilities were provided, their use did constitute an area of examination question paper item. Most of the questions focused on identification of tools and theoretical questions on maintenance of workshop tools and equipment.

It was illogical to provide tools of such magnitude in terms of cost, quality and specialty only for identification. Instead of testing the psychomotor skills and applications on use of the resources, the testing emphasized identification using photographs. This in deed was far from reforms. The study further shows that the type of tools, equipment and

facilities supplied required trained engineers or mechanics technicians, animal husbandry and crop husbandry technicians to handle.

It was a task beyond the competency of an agriculture teacher trained in the general area of agriculture. In the absence of the above, reforms is stifled as the would be user cannot handle the tool. As a consequence the tools and equipment were not only misused evidenced by the magnitude of the remnants of resources and facilities found lying in waste in several schools where such facilities had been supplied either under the Chavakali project, the USAID, IDA and the Kenya Government project schools.

Among the relics includes farm structures, tractors, cultivators, combine harvesters an assortment of tools and equipment like welders, microscopes, engineering surveying equipment and audio teaching resources like over-head projectors. The agriculture buildings which had been considered as a leading mark of schools teaching agriculture had been converted to other uses, such as industrial education, science laboratories, dormitories and general workshop for maintenance.

Reforms and innovations require monitoring and evaluation for continuity or modifications. The study has established that this was not the case with school agriculture. The study shows expansion to more schools without regard to financial implications. This is evidenced by the 1970-74 development plan coming immediately after the USAID and IDA in which a recommendation to construct of 75 agriculture workshops to be built in secondary schools over the plan period. This was in support for the 1969 Agriculture Principles and Practices Syllabus adopted in East Africa. Notably although the workshops were to be constructed, it became apparent that the magnitude of the funding was not sustainable.

The relationship in funding for resources and facilities which had a bearing on teaching methodology is noted with respect to reduced level of funding as compared to the vocational program between 1959 and 1969. Whereas the funding was scaled down, the syllabus remained the same in terms of objectives, content, resource needs and the

teaching methodology. According to (Chrisman,1987) there is evidence of planning as shown by (GoK, 1970-74) development plans shows the initial financing level at a cost of £258,000 or Kshs. 5,160,000 for the 75 agriculture workshops recommended, the average of Kshs. 122,857 per school. In May 1974, the MOE released £14,000 (equivalent to Kshs. 280,000) at an average of Kshs. 20,000 per school to 14 schools for purchase of agriculture tools and requirement.

Documentary sources and the response from the respondents in this study show that after the 1970-74 Development plans, the funding for the subject ceased and therefore the variations in resources and facilities became a reality as the funding levels declined. The provision of resources and facilities similarly ceased. When the funding ceased, the motivation for practical teaching of agriculture also diminished, and the subject turned to be theoretical and any gains made in reforming school agriculture took a downward trend.

The findings of this study shows the 8-4-4 system of education which was to more practical and problem solving curriculum shows to the contrary that it instead entrenched theoretical teaching of the subject by doing away with the requirement of land as a basic facility for teaching the subject. In the absence of land and other resources for teaching the subject, the above recommendations were inconsequential.

A visit to the 43 schools in the study provides summarized findings in Table 1 giving a clear picture of implications of resources to possibilities to reforms. Documentary data and school records show that all the ten USAID and IDA project schools in this study had been supplied with tools, equipment and facilities which when put in the hands of competent teachers, would facilitate creativity in class room work. An interview with the former and current teachers from these schools with regard to the common methods of teaching reveal that only seven out of the 43 had a practical approach to the teaching of the subject. The seven schools fall within the category schools which were not provided with resources but went out on their way to promote creativity. A related finding from the 43 schools visited was the relationship of the school farm as a teaching facility in relation

to possible innovative activities as shown in Table 1.

**Table 1: Category of schools visited in-relation to availability and use of agriculture workshop and facilities for innovative teaching and learning**

Category of school	Number of schools visited	Schools with workshop facilities	Workshops and facilities used in agriculture	Workshops & facilities used for other purposes	Un used workshops and facilities	Schools without workshops and facilities
USAID						
Funded	6	6	0	6	-	0
IDA/ Kenya						
Government	5	5	0	4	1	0
Kenya						
Government						
Funded	12	7	1	6	-	5
Kenya						
Government						
Non funded	20	0	-	-	-	20
<b>Total</b>	<b>43</b>	<b>18</b>	<b>1</b>	<b>16</b>	<b>1</b>	<b>25</b>

Table 1 reveals most insight information. It shows that 25 or 58% of the 43 schools in the study had no workshops, but much more revealing information was that only 13 or 40% of the 32 schools which fell under the Kenya Government had workshops. From the table, it can be seen that none of the 11 schools funded by the USAID or IDA were using the workshops for teaching agriculture. Of the 18 workshops from the 43 schools visited in this study, only one is being used for teaching agriculture. It can be construed that had these few workshops been put in to effective use agricultural technology and indeed reforms and creative teaching would have instituted.

**Table 2: Category of schools visited by availability and use of school farm for teaching agriculture**

<b>Nature of farms in schools</b>	<b>USAID schools</b>	<b>IDA/WB Schools</b>	<b>Kenya Government Funded</b>	<b>Kenya Government Non Funded</b>	<b>Total</b>
Schools with agriculture farms	6	5	12	19	42
Schools with Y.F.C. plots	1	1	2	6	10
Schools with demonstration plots	0	0	0	4	4
Schools with commercial agriculture farms	6	5	12	19	42
Schools with KNEC plots	6	5	12	19	42
School farms under Agriculture teacher	0	0	1	4	5
School farms under head teacher	6	5	11	15	37
Schools without school farms	-	0	0	1	1

Table 2 further shows that out of 42 schools with school farms, only 5 schools had the agriculture teachers involved in managing the school farm for teaching purposes; this reflects that 88% of the schools have school farms whose functions are outside the agriculture teacher's use. Responses from teachers show that the school farms exist only in theory and as such the activities in the farm never show any creativity. Similarly, in all the 42 schools with school farms, it is only in 5 schools where the agriculture teachers are given roles to play in the school farms, this reflects that the school farms are under the total control of the head teachers, or it is only the head teachers who can explain the

roles of school farms under their care. Further findings show that the students are not incorporated in the school farms for any purposes except the Form IV KCSE projects. None of the schools have either the demonstration plots or the Young Farmer's Club plots for practical teaching of the subject which implies absence of leadership and project learning.

### **Conclusions and Recommendations**

The results and the findings confirm that the standards of what would have constituted a reformed school agriculture curriculum were set under the Kenya Vocational Agriculture programme between 1959 and 1974 and those adequate and relevant resources and facilities were provided for the same.

However, it can also be concluded that the teachers of agriculture failed to translate the curriculum objectives in an innovative strategy, they had the resources and facilities on would ask on the quality of their training, their visions and missions for the subject. This is a major reason for the downward trend in school agriculture.

The agriculture teachers have lost control of the school farm which is considered as a laboratory for teaching and experimentation in the teaching of school agriculture. The school farm in an avenue for promoting agricultural entrepreneurship, a key area in reforms in agriculture curriculum. Every student must have a chance to entrepreneurial aspects of agriculture.

Reforms must be sustainable to breed further reforms; short term reform goals cannot withstand the test of change. Self sufficiency at the school level is only a replica for subsistence farming a strategy which only promotes poverty. Most schools view agriculture in this direction and this has created a perception that school agriculture is for the low achieving students. Collaboration with farmers and community development agents would see school agriculture taking lead in areas such as value chain addition. School agriculture remains irrelevant if does not respond to the societal challenges.

The agriculture teacher plays a key role in innovative and creative teaching. The

methodology employed by teachers must be meaningful and enjoyable for both learners and teachers. The agriculture teachers should continue to evaluate, reconstruct, and improve the face of school agriculture as we focus to the next century. However this they will not achieve on their own but the stake holders must provide high quality instructional materials to stimulate reforms in agriculture

The contribution of agriculture teachers in challenges to reforms are more than the factors outside the classroom and the downward trend can be effectively halted by the teachers. There is a need for teachers to include wider participation of community stakeholders in agriculture to determine the agricultural education program in line with the community needs and school syllabuses. These will the teacher to determine where to put emphasis on.

The drive for excellence in examinations has overshadowed the relevance of skills, values and attitudes hence relegating the drive for reforms in which vocational and practical subjects like agriculture struggling to remain afloat. This implies that the provision of resources and facilities for school agriculture has been inconsequential. An analysis from KNEC reports of 1999 and 2016 shows, impressive results from schools on agriculture yet there are no facilities, for teaching the subject in the same schools. The performance has no relations with facilities and resources besides books, teachers and the chalk. This re-affirms the historical misconception that, the teacher is the omnipotent and the unchallenged source of knowledge through the lecture and the chalked –up notes delivered and hence the irrelevancy of resources and facilities. The drive for curriculum reforms in which agriculture is included in the school curriculum has remained a wish and the hopes and aspirations on what school agriculture continues to be elusive.

This paper recommends that hard decisions have to be made on the education and training of agriculture teachers. Many institutions have mounted agricultural education courses. An analysis on the content of their programmes calls for an urgent stakeholder’s conference to determine the mission and philosophy of school agriculture in the country. This will guide those offering agricultural education courses for teachers to address the

downward trend of the subject. Similarly, the Education Ministry needs to define a strategy of monitoring and implementing recommendations from different commissions and committees.

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## Factors Affecting Maize Yield in Machakos County

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### ABSTRACT

Maize is the main staple crop for many people in Kenya. It is a high yielding cereal grown almost in all parts of the country mainly under rain fed environmental conditions. However, despite the fact that maize is the main subsistence crop there has been structural maize deficit in Kenya which has pushed the prices of maize and maize products up beyond affordable level of many households leading to food insecurity. This forced the country to import maize from other countries to cover the shortage and also provide subsidized maize flour at ksh 90 per 2kg packet. There are various factors that affect maize yield and therefore research was aimed at assessing the factors that affect maize yield in Machakos County. The research targeted mainly small-scale and large-scale farmers in Machakos County. The study sought to achieve the following objectives: To examine the maize production and yield trends for the last 10 years in Machakos County. To find out the factors that constrain realization of high maize yield in the county. The research was conducted between July and November 2017 and involved random selection of farmers by visiting them and receiving direct responses from them as they answered the questionnaires. Through the field visits; The questionnaires, interviews and field observations provided the study with primary data. Secondary data was obtained from the Ministry of Agriculture (MOA), National Cereals and Produce Board (NCPB) in Machakos and Kenya agricultural research Centre (KARLO) in Machakos. After data collection, the research findings were analyzed using graphs, frequency tables and percentages and also in regression to establish the relationship between maize yield and the explanatory variables. The research found that maize yield in Machakos county is affected negatively by prolonged droughts and shortage of rainfall due to weather variability, poor soils most of which are very acidic and others are highly alkaline (MOA 2014), lack of agricultural advisory services, lack of essential inputs. The research shall greatly benefit the farming communities comprising of both small scale and large-scale maize producers and also traders of either maize products or farm inputs. The study shall help the farmers to identify the relationship between output and variables that affect the yield they get from their farming activities.

**Key words:** Maize yield, yield trends, Food policy, Food security, Small and large Scale farmers, Machakos county

## **INTRODUCTION**

### **1.1. Background Information**

Agriculture is the mainstay of Kenya's economy and it accounts for approximately 27% of Kenya's gross domestic product (GDP). It is the main source of livelihoods for about 80% of the population in rural areas (MOA 2009)

Maize (*Zea mays*) is the main food crop in Kenya. It is a high yielding cereal grown almost in all parts of the country mainly under rain fed environment and requires minimal capital. It is also used as animal feed especially the maize stalks, can be stored after harvesting and fed to animals at a later period of time. Maize is not only a subsistence crop but also an industrial crop, it is used to make corn oil, flour, beer, quicker oat among others. Maize has a great potential to meet human food requirement because it has a great significance as human food, animal feed and is also an industrial crop hence it is important to analyze the factors that relate to maize yield to ensure that those that affect the yield negatively can be monitored and worked on to ensure improved yield and sustainability. It does well in a wide range of agro-ecological zones and hence the most widely produced crop. Crop yield projections of maize vary widely depending on region and specified climate scenario. Most models predict declining maize yields in large parts of ASALS and in lowlands where Machakos County is not an exemption. Kenya has undergone a transformation from a maize exporting country to maize importing and has lost competitiveness in maize production to the neighboring regions (Nyoro et al,2004). This is being witnessed in the current situation in Kenya where prices of maize and maize products have increased until the government started to provide subsidized maize meal costing sh 90 per 2kg packet. Based on the IFPRI analysis 4 out of 6 climatic scenarios predict an overall decline in rain fed maize yields. Therefore, the research will focus more on factors constraining maize production with much emphasis on the climatic changes, production technologies used, seed varieties, fertilizer, manure and other inputs used. Other variables will also be considered and these include the social and economic characteristics of maize farmer such as education level, gender among others. All these will be geared towards achievement of the objectives listed below.

## **1.2. Problem Statement**

Despite the fact that maize is the staple food of many people in Kenya, there has been rise in price of maize and maize products such as flour not only in Machakos but all over Kenya rendering many households both in rural and urban areas to be food insecure. According to the food security assessment report from the ministry of agriculture that was done in march 2013, The cyclonical droughts experienced in many counties especially those on the lower eastern part of Kenya for example Machakos county have severely hampered efforts to improve the food security situation in the county. House hold crop production is currently of little significance to house household food security as over 98% of cereals are imported from high potential neighboring counties of Machakos such as Kiambu and this drives the prices of food up to cover transportation costs. Most small-scale farmers in Machakos County are almost giving up on maize production and shifting to production of drought tolerant crops such as green grams so that after harvesting the green grams which normally fetch much better prices in the market they will sell them then buy maize. This is after continuous failure of maize crops which has left many of them without food after incurring so many production costs only to get losses.

Following the increase in maize yield from 39 million 90kg bags on 2014 to 42.5 million bags on 2015 the food was projected to sustain the country all through the year of 2016 and 2017 and prices were expected to remain fairly constant around ksh 100-120 per 2kg packet (FAOSTAT, Economic survey 2016), however contrally to this, Kenya is Currently suffering from structural deficit of maize production that has culminated to price rise to even ksh 200 per 2kg packet until lately when the government started to import and provide subsidized maize flour at ksh 90 per 2kg packet. This does not fully contribute to food security since as soon as that flour arrives in the supermarkets and shops people buy it all and even some do not find it due to the high demand for the same relative to the supply.

## **1.3. Research Objectives**

### ***1.3.1. General Objective***

To find out the factors that affect maize production and yield in Machakos county.

### ***1.3.2. Specific Objectives***

To examine and analyze production and yield trends of maize in Machakos county for the last 10 years.

To find out the factors that constrain realization of high maize yield in Machakos county.

### **1.4. Research Questions**

The research sought to answer the following questions:

What are the trends in maize production for the last 10 years in Machakos County?

Which factors constrain maize production in Machakos County?

### **1.5. Significance of the Study**

It is important to undertake a study on maize yield since yield is an aspect of sustainability and according to the agricultural transformation agenda some of the reasons for targeting maize as an ideal crop for intensification in rural areas include: high yield potential of maize, diversified uses, ease in transporting, processing and marketing and most importantly its contribution to food security. Understanding the factors affecting maize yield will make it easy to address most of the challenges that are constraining maize production not only in Machakos county but also to the entire lower eastern region of Kenya and all over the country hence curb the issue of importing maize and encourage sustainable production.

### **1.6. Justification of the Study**

The researcher chose this topic of study following the maize crisis that we were then facing in the country, Kenya. As a result of maize shortage, the prices of maize and maize products such as flour have increased beyond affordable levels putting both rural and urban populations at risk of being food insecure. If this shortage persists then almost everyone in the country will be vulnerable to food insecurity. The research will contribute to efficient and sustainable production of maize to curb the prevailing maize insecurity situation in Kenya. This was achieved through interaction with the maize farmers both small and large scale producers in the selected research sites, and helping them to identify the key factors that constrain maize production and find a way out.

### **1.7. Assumptions of the Study**

The study assumed that the respondents participated honestly in answering the

questionnaires.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

Maize belongs to the family of grasses and is scientifically name *Zea mays*. It is a high yielding, easy to process crop and a good source of carbohydrate and survives in a wide range of agro ecological zones although it does best in warm climate. It has a short life cycle making it the first crop to harvest for food during hunger periods in Kenya.

Most agricultural production in Kenya is dominated by maize which is comprises 38.2% and dry beans (18.7%), and the two together make a half of the total cropped area. Maize production accounts for approximately 80.3% by volume of Kenya total grain output and it is packed and marketed in 90 kg bags, however yields for small holder farmers are generally low since most of their production are dependent on rainfall. (FAO 2010)

According to Byerlee and Eicher , 1997, maize is the most important and widely consumed cereal in kenya.it is the staple food of for 96% of Kenya's population with 125kg per capita consumption and provides 40% of the calorie requirements. About 70-80% of maize is produced by smallholder farmers. Self-sufficiency in maize production was achieved in 1970s when production was high and the surplus was exported.

In MY 2015/2016, Kenya's corn production increased due to effects of higher rainfall in the

marginal corn growing areas attributed to the El Nino weather phenomenon. However, current trends show that the country is struggling to achieve self-sufficiency in major staples including maize.

Kenya's corn production remains constrained by underlying factors such as soil acidification due to continuous multi-year use of Di Ammonium Phosphate (DAP) fertilizer, lack of access to improved seeds, and the impact of maize lethal necrosis (MLN). The Government of Kenya (GOK) and the county governments in the corn growing areas have initiated measures to increase yields including distribution of certified seeds and alternative fertilizers to farmers.

According to GOK 2010, Kenya has experienced years of heightened food insecurity and

dependence on imports and emergency humanitarian assistance in the last one decade where in 2009 Kenya imported 16.8 million bags of maize. Even in the current period Kenya is still importing maize. Maize demand in the country has been on increase outstripping supply thereby necessitating imports.

Maize consumption in Kenya whose population is currently over 40 million is projected to be about 3.2 million bags per month which amounts to 40 million bags per year. Despite the overall positive food security outlook in the non- ASALS, the situation in the Kenyan arid and semi-arid lands have deteriorated due to poor performance of rains in 2016, whereby there was delay in short rains. These ASALS which comprise of but not limited to the counties in the lower eastern region, especially Machakos are most susceptible to food insecurity due to low yields realized after receiving little or no rains (MOALF 2016).

Retail prices for corn and corn products have decreased after Kenya's National Cereals and Produce Board (NCPB), a GOK agency, lowered the purchase price for the strategic reserves in 2015 from Ksh 3,000 per 90 kg bag to Ksh 2,300. Some of the farmers in key maize growing areas reacted to the price changes by diversifying to other crops. NCPB's corn purchase price is still far higher than the prices offered to farmers in the neighboring EAC countries, creating an incentive for imports from these countries.

Thorton.et al. (2009) predicts a maize production decline of 8.4% in ASALs. This decline is very dangerous since it threatens food security situation for the residents of these areas.

## **2.1 Conceptual framework**

The conceptual framework is a summary of the factors that affect maize yield in Machakos County. It is comprised of independent variables, moderating variables and the dependent variable. The independent variables are those factors that affect the dependent variable or maize yield. They include demographic characteristics of farmers such as gender; male or female, age of the farmer in years, education level, years of farmers experience in maize farming and membership in farmer organizations or cooperatives; Characteristics of the farm like size, inputs used such as fertilizer, manure and seeds varieties

Sources of labor either family labor or hired and other economic activities of the farmer

such as casual jobs, livestock keeping; rainfall trends and prices of maize.

Moderating variables include government policies such as input policy, credit policy and food policies and culture.

The dependent variable is maize yield in tons.

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

This chapter will comprise of site selection and description, research design, target population and scope of study, the methods and tools that were used in data collection, validity of data tools, data analysis and presentation and ethical consideration.

#### **3.1 Site Selection and Description**

The research was carried out in Machakos County, a county in the lower eastern region of Kenya. The county has a population of 1098584 people (as at 2009) and is about 6208.2km. The county borders Nairobi and Kiambu Counties to the west, Embu to the North, Kitui county to the east, Makueni county to the south Kajiado to south west Murang'a and Kirinyaga to North West. The climate of the county is semi-arid with a hilly terrain and an altitude of 1000-2100M above sea level. It experiences a bimodal rainfall mode with the long rains expected to start from march to May and short rains fall from October to December hence two cropping seasons per annum; the temperature ranges between a minimum of 15.50C and a maximum of 31.50C per annum. (Kwena et al., 2011)

#### **Demographic characteristic of the county**

The population is approximately 1.098583 million as per 2009 Kenya population housing census where 49% are male and 51% female. Age distribution is 0-14 years 39%,15-29 years is 28%,30-64 years 27.7%,above 65 years 5% (GOK 2010). Agriculture is practiced with maize and other Drought resistant crops such as sorghum and millet being grown due to areas semiarid nature. The land has generally been underutilized for agricultural production. The ASALS which cover 84% of the total land are also underutilized.

The study was conducted in the following sub counties

*Table 3.1. Description of study districts*

District	Area km <sup>2</sup>	No. of respondents
Masinga	1402.8	20
Yatta	1057.3	20
Machakos central	925.5	10
Mwala	1017.9	10
Kathiani	207.1	10

Source : county commissioner offices Machakos ,2013

### **3.2. Research Design**

The study used explanatory and descriptive research design that involved field visits and administration of questionnaire to understand how different variables affect maize yield. The study also involved exploration of secondary data on maize yield trends and weather patterns specifically rainfall trends.

### **3.3. Target Population and Scope of the Study**

The target population included the small and large-scale maize farmers who were picked at random from different constituencies. The study was only limited to Machakos county in the following five districts; Masinga, Machakos central, Yatta, Mwala and Kathiani.

### **3.4. Methods and Tools of Data Collection**

The study used both primary data and secondary data. Secondary data was obtained from the ministry of agriculture, Machakos.

The study used the following tools to collect primary data; questionnaire, interviews and field observations provided primary data.

Questionnaires consisting of printed questions were issued to the farmers in Machakos County. The questionnaires are more economical to use due to their lower cost .it is also through questionnaires that a large number of farmers was reached over a wide geographical area.

The research used both open ended and closed ended questionnaires though the closed ended questionnaires were more dominant since they gave farmers choices of all possible answers where they could only tick. Open ended questionnaires were also

included even though they are few farmers were allowed to write answers in their own words.

The researcher conducted interviews during the issuing of questionnaires since it was just a short dialogue between the farmer and the researcher. The research was more interactive since the researcher just dealt with individual farmer at a time and this made the research also confidential.

### **3.5. Validity of Data Tools**

The research questions were presented to the supervisors to check the objectivity of questionnaires that were used to collect the data and they gave a go ahead.

### **3.6. Data Analysis and Presentation**

The data from questionnaires was recorded in excel tables and the response rate was analyzed using descriptive statistics such as frequency and percentages then it was presented using bar graphs, line graphs and pie charts.

### **3.7. Ethical Consideration**

The research provided the dignity and privacy of every individual by ensuring that personal details were limited to general information and no names, identification number or telephone number was enquired from the respondents. The information was used in fulfillment of the researcher's academic requirements only.

## **CHAPTER FOUR**

### **RESEARCH FINDINGS AND DISCUSSIONS**

#### **4.1. Introduction**

This chapter comprises of the research results of both secondary and primary data. The results are meant to achieve the two research objectives on maize yield trends and factors affecting the yield. It will include maize yield trends from 2000-2014, Regression results and their discussions, rainfall trends, Data variables used in the questionnaires and their discussions and other variables used in the study.

## 4.2. Maize Yield Trends

Table 4.2 maize yield trends in Machakos county

YEAR	Secondary Data Maize Trends In Machakos County					Prices of maize		Price of fertilizer
	area in ha	yield in tons	Long Rains in mm	Short Rains in mm	Station	Buying price 90 kg bag	Selling price 90kg bag	
2000	162000	58320	143	575	Katumani	980	1150	2000
2001	163880	78034	229	276	Katumani	1000	1250	2400
2002	153580	87685	356	398	katumani	1050	1600	2350
2003	145000	59850	404	231	Katumani	1450	1800	2450
2004	152000	27765	238	357	wamunyu	1500	1850	2430
2005	170000	15300	145	178	wamunyu	1350	1800	2000
2006	167225	119330	302	367	wamunyu	1350	1500	2200
2007	145500	71295	238	337	wamunyu	1455	1700	2550
2008	138750	78578	202	262	mikuyu farm	1500	1850	3500
2009	170000	142800	53	327	mikuyu farm	1800	2000	3550
2010								
2011								
2012	117600	140000						
2013	117600	140000						
2014	152000	80000						

Source : ministry of agriculture, Machakos

As shown in figure 4.2 above Machakos county has been having fluctuating trends in maize yield over years from 2000-2014. The highest yield was realized in in the year

2009,2012 and 2013 with production of 140000 tons of maize and the lowest in 2005 15300 tons .In the years 2003,2004,2005,2007,2008 and 2014 the maize yield in the county was below the trend line and this is very dangerous since it increases vulnerability to food insecurity.

Yield is not significantly affected by the size of land, this is because there are some years when the land size was big but the yield was very little. For example, comparing between 2005 and 2009 the land size was almost equal but maize yield in 2009 was very high compared to 2005 which was too low. This indicates that there are other factors rather than land size that affect the maize yield for example drought. The productivity of land depends on availability of water or rainfall, inputs and agronomic technologies used.

The equation for maize yield is

$$Y = 106.59R + 1.0 L - 2705.9A - 27569M - 53460.8F + 6.89BP - 51.41SP + 44.21PF$$

Where: R - Rainfall, M- male F- female BP-Buying price of maize, A – age of farmers

SP- selling price of maize, L is land size, PF- price of fertilizer

Age is also significant in determining the yield of maize.

From the questionnaires many farmers are aged between 51-60 years. This shows that they are the ones who participate mostly in maize farming and the main reason for this could be because they are the only ones who own land hence most young people cannot do maize farming due to lack of land.

There's significant difference in yield between male and female farmers. This indicates that there is gender gap in agriculture.

The price of fertilizer doesn't affect maize yield very much, this is possibly because farmers use manure instead of fertilizer.

The selling price does contribute significantly to maize yield. This is because an increase in price of maize motivates more farmers to produce maize since out of it they can make some sensible income. However, the coefficient for selling price of maize is -51.41, this indicates that the NCPB has been buying maize from farmers at poor prices and this has a

negative effect on maize production since farmers will shift from maize production to producing other crops that fetch higher prices like green grams.

The  $R^2$  is 0.99 which indicates that 99% of variation in maize yield in Machakos county is due to the variable factors such as weather variability particularly rainfall, limited agricultural land expansion, prices of maize, high cost of fertilizer, gender inequality in agricultural and age of farmers. The other 1% is due to other factor that were not included in regression such as education level, pest and diseases, declining soil fertility, poor quality seeds and diversion of farmers from maize production to other enterprises.

The P-values for annual rainfall, area under maize, age, gender, selling price of maize and price of fertilizer as shown in the table above indicate that they are significant in determining maize yield in Machakos Count

**Table 4.5 Data Variables**

Table 4.5	VARIABLES		Total Frequency	Percentage
	No. Of Respondents		70	
A	Background Information Of Farmers			
	VARIABLES	Description		
1	Gender	Male	34	48.57%%
		Female	36	51.43%%
				100%%
2	Marital Status	Married	50	71.43%
		Single	20	28.57%
				100.00%
3	Educational level	Adult education	7	10%
		Primary	18	26%
		Secondary	26	37%
		Higher level	19	27%
				100%
4	Age in years	20-30	12	17.14%

		31-40	14	20%
		41-50	16	22.86%
		51-60	23	32.86%
		Above 60	5	7.14%
				100.00%
5	Experience in maize farming	1-5 years	12	17.14%
		5-10 years	17	24.29%
		10-15 years	21	30%
		over 15 years	20	28.57%
B	Information On Maize Production			100
1	Mode of land acquisition	Inherited	19	27.14%
		Purchased	11	15.71%
		Rented	9	12.86%
		Family land	31	44.29%
				100.00%
2	Cropping system	maize mono crop	17	24.00%
		maize intercrop	53	76.00%
				100.00%
3	crop rotation	Yes	42	60%
		No	28	40%
				100%
4	seeds used	local varieties	31	44.00%
		improved varieties	39	56%
				100%
5	Time of planting	Before rains	21	30%
		onset of rain	39	56%
		later after onset	10	14%

				100%
6	Input use	Fertilizer	8	11%
		Manure	37	53%
		Both	25	36%
				100%
7	Farm uses of maize	Consumption and seed	57	81%
		for sale	13	19%
				100%
8	Agric extension services	Yes=1	18	26%
		No=2	52	74%
				100%

#### 4.5.1 Gender

As shown in table 4.5 above more than half of the respondents were female that is 51.43% and less than half was male that is 48.57%. This is a clear indicator that the study was gender sensitive and both genders were well represented. It also shows that both men and women participate in maize farming.

#### 4.5.2 Marital Status of Respondents

The researcher only decided to use two choices for marital status i.e married and single. Both divorced and widow statuses were combined as married. As shown in table 4.5 above more than half, 71% of the total study population is comprised of married people while less than half comprise of unmarried people that is 29%. Marital status also affects maize yield.

#### 4.5.3 Educational level of respondents

The research analyzed the educational level of the respondents and found that the highest percentage of respondents that is 37% had learnt up to secondary level, 27% had higher level of education, 26% primary level and 10% had adult education see table 4.5. The

education level of a farmer affects the level of yield due to ability to read, interpret and respond to new information and this also determines their adoption on information on use of improved and appropriate technologies and other activities. Farmers who are less educated find it hard to receive and adopt new farming technologies.

#### ***4.5.4 Age in years***

The study sought to establish the age of the maize farmers and as shown in table 4.5 above a high percentage of the farming population is aged between 51-60 years with 33% of the total number of respondents, followed by those aged between 41-50 years 23%, then 31-40 year with 20%, 20-30 years with 17%. Those aged above 60 years have the least percentage with 7%. This indicates that most of the maize farmers are aged between 51-60 years and 41-50 years because they are the ones who own land hence can do farming.

#### ***4.5.5 Years of Experience in Maize Farming***

The study also sought to find out the respondents' years of experience in maize farming. As shown in Table 4.5 above, a high number of respondents had experience of 10-15 years of experience in maize farming, 28.57% had above 15 years of experience in farming, 24.29% had 5-10 years and 17.14% had 1-5 years of experience in maize farming. Experience in maize farming is significant in maize yield because as years pass on with continuous maize farming farmers' capacity to make improvements in maize farming increases hence increase yield. As time goes on with continued farming, farmers gain skills and knowledge necessary to make choice of the best farming technologies to use.

#### ***4.5.6 Mode of land acquisition***

The study also sought to find out the mode of land acquisition and from the results as shown in table 4.5, 44.29% cultivated their maize on family land, 27.14% use inherited land, 15.71% purchased their land and 12.86% rented land

##### **4.5.6.1 Size of land**

The researcher presented an open-ended question to farmers on the size of their land and most of the farmers own a land that is less than 10 hectares hence they do small scale

farming.

#### ***4.5.6.2 Proportion of land under maize***

Most farmers have set aside almost a half proportion of their total land to maize planting. This indicates that they value maize as their main food crop that can solve food security problem.

#### ***4.5.7 Cropping system***

A great percentage of the sampled farmers use intercropping system that is 76% while less than half, 24% plant maize as a mono crop. Most farmers gave reasons why they use intercropping system such as small size of farm land and since they want to maximize use of that small land then they intercrop maize with many other crops such as beans, cowpeas, peas. And green grams. The study also indicated that most of farmers who plant maize as a mono crop are only doing maize farming for commercial purposes while those who intercrop maize with other crops, grow it for consumption purposes.

#### ***4.5.8 Crop rotation***

The study also sought to find out whether the farmers practice crop rotation and found that more than half of the respondents that is 60% practiced crop rotation while 40% did not practice crop rotation and the main reason they gave is still on small size of land. Common crops rotated with maize include legumes such as beans, cow peas, green grams and cereals like sorghum, millet.

#### ***4.5.9 Maize varieties and their Sources***

The study classified maize varieties used as either local varieties or improved varieties. As shown in table 4.5, the study found that more than half of the respondents that is 56% use improved varieties while less than half that is 44% still use the local varieties commonly known as kikamba in the local language. Improved varieties include Katumani, Duma 42,43.Pioneer,Dekalb as given by the farmers during the study. Those

still using local varieties gave reasons for using them due to their high productivity in the region, high cost of the improved varieties in the market where a packet of 2kg maize like Duma 43 costs over ksh 300 compared to local varieties which they would buy from the local shops at most sh 35 per kilo. The varieties of maize use affect yield because some of the varieties are designed to suit the rainfall patterns of the area for example Katumani is a drought resistant variety.

#### ***4.5.10 Time of planting***

The study established the time of planting and found that more than half of the respondents that is 56% plant on the onset of rainfall, 30% plant before the onset of rains and 14% plant later than one week after onset of rainfall. The time of planting affects maize yield because of the rain pattern and high sensitivity of maize to water availability (rainfall). Planting later after onset is brought about but not always by lack of oxen to plough the shamba on time where those farmers who don't have their own oxen usually wait for those who have oxen to first plough their own farm then they plough for them later when time has already passed by, this in turn makes their maize unable to produce because sometimes the rain season is too short.

Other farmers who plant before onset also face a challenge because the rain patterns are unpredictable and in most of the times, the onset delays when the farmers have already planted this is a loss to them because once the seeds fail to germinate, no one compensates them for the loss.

#### ***4.5.11 Input usage***

Input usage was only based on fertilizer, manure or both. According to the study more than half of the respondents 53% use manure, 36% use both manure and fertilizer, and 11% use fertilizer only. The large number of farmers using manure is because of its ready availability compared to fertilizer which is attributed with high costs. The question on type of fertilizer use was open ended hence farmers listed them such as Ammonium phosphate (DAP), Calcium Ammonium nitrate (CAN) and urea. Of the manure users 85% use cow dung while 15% use green manure. Input usage affects yield because they supply the plant with the important nutrients.

#### ***4.5.12 Farm uses of maize***

The study sought information about the uses of maize and the result indicated that

more than half of the respondents 81% use maize for consumption and seeds while 19 % grow maize for sale.

#### **4.5.13 Agricultural extension services**

A great number of respondents, 74% don't receive agricultural advisory services and those that receive those advisory services 26% said that the delivery is also done poorly. Agricultural advisory services are important in yield through these services the farmers are taught on the best agronomic practices and also dissemination of agricultural technologies to farmers.

**Table 3.20 Maize pests and diseases encountered by maize farmers**

Pests include

Pests	How farmers manage them
Squirrels	Scare away Use of scarecrows Some use poison
Birds	Chase away
Stalk borers	Chemicals
Cutworms	
White ants	Use of wood ash by pouring it at the base of the maize plant. Use of chemicals
Diseases	
Maize smut	Destroy and burn infected plants
MLND	“

Other variables used in the study

The study also assessed those farmers who have organized themselves into cooperatives

and other organizations, land preparation before planting, other economic activities that the farmers are involved in rather than farming and sources of farm labor.

#### ***Farmer organizations.***

From the interviews, The research found that only a few farmers have organized themselves into groups and these few are mostly women who usually have merry-go-round usually termed by locals as 'Mwethyia'. Many women have grouped themselves into different saving groups where they can save money and share after a given period of time, others save and when it approaches rain season they buy things like fertilizer, seeds and other farm inputs in bulk at a cheaper cost and they share amongst themselves. This helps solve input constraints by farmers. Being in these groups also saves farm labor constraints since as most farmers responded during the interviews when the time to cultivate comes they can help each other in eliminating the weeds by visiting each members' farm and helping each other to cultivate.

#### ***Land preparation before planting***

Land preparation is also a very important determinant of yield because it's through land preparation that one clears weeds and bushes that might have grown and also ploughing land during the dry season reduces soil compaction hence facilitate easy water infiltration into the soil once it rains. Farmers gave different ways through which they prepare their shambas before planting. Some use ox plough others use jembes to hand dig their farms.

#### ***Farmers other activities rather than maize farming***

Farmers in Machakos county undertake many other activities rather than maize farming. Some are livestock keepers, keeping a wide range of livestock such as cattle, goats, sheep and poultry. Keeping livestock while you are a maize farmer is very economical since the stocks from maize can be fed to the animals and in turn the animals provide manure inform of cow dung. Other farmers have donkeys that help them do some activities such as fetching water from the river and selling it in the local market hotels and also selling to those people who are far away from the river; this gets them a good source of income especially during the dry seasons which are usually very long in the county.

There are other farmers who also do some formal casual labor employment, others do small businesses like retail shops, small hotels, selling vegetables in the market and others charcoal burning when life gets hard.

### *Sources of farm labor*

Many farmers use family labor to cultivate their farms, others hire labor .in most cases the family labor is inefficient especially where the family household is small hence little yield. Those farmers who are in groups may not have some labor constraints since they may decide to help each other to cultivate by setting dates to visit each member farms in turns.

## **CHAPTER FIVE**

### **SUMMARY OF RESEARCH FINDINGS, CONCLUSION AND RECOMENTATIONS**

#### *5.1 Summary of Key Findings*

The study found that over the last ten years there has been fluctuating trends in maize yield and weather pattern trends and prices of maize. According to Kenya agricultural sector risk assessment report 2015 maize production in Kenya is dependent on rainfall and is vulnerable to drought and year to year fluctuations, this is also in line with a study by La Rovere et al2014 which suggest that nearly a fifth of maize production takes place in areas with high rainfall variability. The area under maize has not changed very much and this indicates that there are other factors rather than land size that affect maize yield, This is also in line with Stephen et al 2015 that increase in maize production since 1990s is driven by nearly 40 percent growth in land under cultivation it is only that this expansion is done in marginal areas where the soils and rains are less favorable to maize production. More than half of the respondents were female that is 51.43% and less than half was male that is 48.57%. This is a clear indictor that the study was gender sensitive and both genders were well represented. It also shows that both men and women participate in maize farming there is also gender gap in agriculture according to Malapit et al 2014 hence need for gender empowerment in agriculture.

According to the findings, 71% of the total study population is comprised of married people while less than half comprise of unmarried people that is 29%. The research

analyzed the educational level of the respondents and found that the highest percentage of respondents that is 37% had learnt up to secondary level, 27% had higher level of education, 26% primary level and 10% had adult education. The education level of a farmer affects the level of yield due to ability to read, interpret and respond to new information and this also determines their adoption on information on use of improved and appropriate technologies and other activities. Farmers who are less educated find it hard to receive and adopt new farming technologies. The study established the age of the maize farmers and found that high percentage of the farming population is aged between 51-60 years with 33% of the total number of respondents, followed by those aged between 41-50 years 23%, then 31-40 year with 20%, 20-30 years with 17%. Those aged above 60 years have the least percentage with 7%. This indicates that most of the maize farmers are aged between 51-60 years and 41-50 years because they are the ones who own land hence can do farming.

The respondents' years of experience in maize farming As shown in Table 4.5, a high number of respondents had experience of 10-15 years of experience in maize farming, 28.57% had above 15 years of experience in farming, 24.29% had 5-10 years and 17.14% had 1-5 years of experience in maize farming. Experience in maize farming is significant in maize yield because as years pass on with continuous maize farming farmers capacity to make improvements in maize farming increases hence increase yield. As time goes on with continued farming, farmers gain skills and knowledge necessary to make choice of the best farming technologies to use.

The mode of land acquisition from the results as shown in table 4.5, 44.29% cultivated their maize on family land, 27.14% use inherited land, 15.71% purchased their land and 12.86% rented land to farm.

#### Size of land

The response from the open-ended question on the size of the land indicates that most of the farmers own a land that is less than 10 hectares hence they do small scale farming.

#### Proportion of land under maize

Most farmers have set aside almost a half proportion of their total land to maize planting. This indicates that they value maize as their main food crop that can solve food security problem.

The research indicate that a great percentage of the sampled farmers use intercropping system that is 76% while less than half, 24% plant maize as a mono crop. Most farmers gave reasons why they use inter cropping system such as small size of farm land and since they want to maximize use of that small land then they intercrop maize with many other crops such as beans, Cowpeas, peas pumpkins and green grams. The study also indicated that most of farmers who plant maize as a mono crop are only doing maize farming for commercial purposes while those who intercrop maize with other crops grow it for consumption purposes

The study also found that more than half of the respondents that is 60% practiced crop rotation while 40% did not practice crop rotation and the main reason they gave is still on small size of land. Common crops rotated with maize include legumes such as beans, cow peas, green grams and cereals like sorghum and millet.

The study found that more than half of the respondents that is 56% use improved varieties while less than half that is 44% still use the local varieties commonly known as kikamba in the local language. Improved varieties include Katumani, Duma 42,43.Pioneer,Dekalb as given by the farmers during the study. Those still using local varieties gave reasons for using them due to their high productivity in the region, high cost of the improved varieties in the market where a packet of 2kg maize like Duma 43 costs over ksh 300 compared to local varieties which they would buy from the local shops at most sh 35 per kilo. The varieties of maize use affect yield because some of the varieties are designed to suit the rainfall patterns of the area for example Katumani is a drought resistant variety.

The study established the time of planting and found that more than half of the respondents that is 56% plant on the onset of rainfall,30% plant before the onset of rains and 14% plant later than one week after onset of rainfall. The time of planting affects maize yield because of the rain pattern and high sensitivity of maize to water availability(rainfall). Planting later after onset is brought about but not always by lack of oxen to plough the farm on time where those farmers who don't have their own oxen usually wait for those who have oxen to first plough their own farm then they plough for them later when time has already passed by, this in turn makes their maize unable to produce because sometimes the rain season is too short.

Other farmers who plant before onset also face a challenge because the rain patterns are unpredictable and in most of the times, the onset delays when the farmers have already planted this is a loss to them because once the seeds fail to germinate, no one compensates them for the loss

According to the study more than half of the respondents, 53% use manure, and 36% use both manure and fertilizer and 11% use fertilizer only. The large number of farmers using manure is because of its ready availability compared to fertilizer which is attributed with high costs. The question on type of fertilizer use was open ended hence farmers listed them such as Ammonium phosphate (DAP), Calcium Ammonium nitrate (CAN) and urea. Of the manure users 85% use cow dung while 15% use green manure. Input usage affects yield because they supply the plant with the important nutrients

The study indicated that more than half of the respondents 81% use maize for consumption and seeds while 19 % grow maize for sale. According to kirimi et al 2011 three out of every five smallholder farmers are net maize buyers

According to the study, most respondents; 74% don't receive agricultural advisory services and those that receive those advisory services 26% said that the delivery is also done poorly. Agricultural advisory services are important in yield through these services the farmers are taught on the best agronomic practices and also dissemination of agricultural technologies to farmers

## **5.2 Conclusion**

The study found that maize yield is affected by many factors. Decline in maize production in the past years has been as a result of the unpredictable weather patterns especially variability of rainfall in Machakos county, lack of agricultural advisory services, limited agricultural land expansion, low producer prices, lack of access to inputs such as fertilizer due to their high cost declining soil fertility ,poor quality seeds and pest and diseases infestation. Farmers are also involved in other activities such as small businesses, casual employments that destruct their farming activities this also reduces yield since they concentrate more on those activities and forget to work on their farms. Despite the fact that maize production is cheaper than buying, production is still below average leading to poverty and food insecurity and also making maize a rich man's

product, necessitating imports. This calls for government to implement agricultural policies such as input policy like subsidizing the prices of fertilizer and other inputs and credit policy.

### **5.3 Recommendations**

- Input policy to be implemented in rural areas to ensure that farmers can access the key inputs like fertilizers at subsidized prices.
- Encourage farmers to join cooperatives since they will be able to get credit facilities at low interest rates. They can also form merry go rounds and other associations. Farmers should be encouraged also to form farmer organizations where it will be easy for them to have better access to inputs like fertilizers, improved maize varieties and also when in groups or organizations farmers can share information among themselves and get information on improved farming activities.
- Encourage the educated youth to take up agricultural farming as a business.
- Early warning mechanism should be implemented by the Kenya meteorological department to keep farmers informed on the rainfall expected and onsets because the weather has become unpredictable.
- The government should Encourage appropriate agricultural advisory service delivery by deploying more agricultural extension officers to reach many farmers and disseminate agricultural technologies in rural areas.
- Encourage farmers to use manure by training them how to make farm yard manure or compost manure using local materials at their disposal since most of them use only cow dung because they do not know how to make other types of manure. Encourage farmers to plough their land before planting to increase water infiltration into the soil to reduce run offs that cause soil erosion.
- Implementation of all these will lead to an increase in maize yield by a bigger margin.

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**Impact of Agricultural Output on Economic Growth in Nigeria and Ghana (1985-2014): A Comparative Analysis**

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**ABSTRACT**

This paper examined comparatively the “impact of agricultural output on economic growth in Nigeria and Ghana”. Nigeria and Ghana have similar economies and the striking similarities are that both countries have agriculture as the mainstay of their economies and have been experiencing a declining contribution of agriculture to GDP. Since both countries have similar economies, it is interesting to know which of the country’s agriculture output contribute more to their GDP and why so that the other will learn from the experience of the other. That constitutes the problem of this study. The main aim of this study was to investigate the impact of agricultural output in stimulating growth in both countries. A model was formulated to give empirical content to the stated hypotheses which were analyzed via the Vector Error Correction (VEC) Mechanism. Data was collected from relevant sources for 30 year period spanning 1985 to 2014. It was collected for variables such as for the agricultural output, industrial output, services output and Real Gross Domestic Product (RGDP). The study showed, the coefficients of the variables in Nigeria as follows; AGO (-1.97), IDO (2.21) and SVO (-1.81) which implies that the contribution of agriculture to GDP is insignificant in accelerating economic growth as compared to other sectors, however, industrial sector perform better in Nigeria than Ghana while in Ghana the coefficients are AGO (2.52), IDO (0.42) and SVO (1.44), which implies that in terms of contribution to GDP, agriculture contributed to Ghana GDP than other sectors followed by service sector. The paper concluded that there exists a significant difference in the impact of agricultural output oneconomic

growth in Nigeria and Ghana. The study therefore, recommended amongst others that; first, the government of Nigeria and Ghana should make efforts in increasing the expenditure in the agricultural sector. Secondly, that, given the potential of the agricultural sector, Commercial Banks, Bank of Agriculture and other financial institutions in Nigeria should channel more loans and credit facilities to the sector in order to encourage farmers to increase output through improved seedlings, adequate manure and proper land usage. Finally, policies aimed at increasing the quality of agricultural outputs should be initiated, implemented and used as major tools that would precipitate economic growth in Nigeria and Ghana. More farm implements and inputs should be provided to boost output growth.

**Keynote:** Real gross Domestic product (RGDP), Service Output (SVO), Industrial output (IDO) Agricultural output (AGO)

## **INTRODUCTION**

### **1.1 Background to the Study**

Agriculture is the mainstay of Nigeria and Ghana economy and the contribution of agricultural sector to these economies cannot be underestimated when considering its building roles for sustainable development. In terms of employment creation, export and financial impacts, agriculture is an important sector in these countries. The sector provide food for the teeming population, provide raw materials for the industrial sector, (Ogunbayo, Omojolaibi, & Omonona, 2014 & Ghana Statistical Service, 2007):. It also serves as a source of foreign exchange and revenue (through tax) to the government; and contributes to Gross National Products (GNP) amongst others (Oguamanam, 2004)

Despite the dominance of these economies by oil and gas in recent time, agriculture still remains the most important source of economic resilience in Nigeria and Ghana.

It is on this premise; this research was conducted to comparatively, examine the impact of agricultural output on economic growth between Nigeria and Ghana.

### **1.2 Statement of the Problem**

Nigeria and Ghana have similar economies and the striking similarities between Nigeria and Ghana are; both countries are agrarian economies and are oil producing countries. In addition, both countries have been experiencing a decline contribution of agricultural to

growth of GDP. Given the potentials of agriculture in stimulating economic growth, several governments in Nigeria and Ghana have initiated several policies and programmes to attract finance in order to revitalize the sector. Some of these policies were in form of specialized lending to farmers, farm inputs support and agricultural subsidies given to farm inputs. The expectations is that these policies via increased agricultural inputs should be able to translate to positive agricultural output and consequently economic growth in Nigeria and Ghana. The problem however, is that since Nigeria and Ghana have similar economies, it is important to know which of these countries agricultural output impact more on economic growth and why so that the other can learn from the experience. This however, constitutes the problem which has already be addressed.

### 1.3 Objectives of the Study

The main aim of this research work is to examine the impact of agricultural output on economic growth in Nigeria and Ghana.

*The specific objectives of the study are to:*

- Compare the impact of agricultural sector output on economic growth to the impact of other major sectors outputs in Nigeria and Ghana.
- Investigate how agricultural output impact on economic growth in Nigeria as compared to Ghana.

### 1.4 Research Hypotheses

H<sub>01</sub>: Agricultural sector outputs have no significant impact on economic growth as compared to other major sector's output in Nigeria and Ghana

H<sub>02</sub>: Agricultural outputs have no significant impact on economic growth in Nigeria as compared to Ghana.

### 1.5 Significance of the Study

The study will also be important to institutions, students, lecturers, researchers and other thinking minds that might still have the interest to research on the area. Therefore, this study will contribute to the knowledge gap in empirical literature on agricultural output-economic growth nexus thereby serve as a basis for further research

work.

This study will be useful to farmers who are the major stakeholders in agriculture and who are the beneficiaries of agricultural inputs such as: extension services, credit facilities, farm inputs, machineries, government allocation to agriculture, and agro-allied chemical as the findings and the recommendations of this study will help government of Nigeria and Ghana to subsidize these agricultural inputs at affordable rate for farmers thereby increase agricultural output.

## **1.6 Scope of the Study**

This study investigated the impact of Agricultural output in Nigeria and Ghana between the period 1985 and 2014. This period is considered relevant because it was characterized by substantial growth in government expenditure on agriculture and it reflects the period of Structural Adjustment Programme (SAP) in Nigeria (1986) and Ghana (1985) which was initiated to restructure and diversify the productive base of these economies to reduce the dependence on oil and imports. The choice of these periods is to empirically examine the extent agricultural output contributes to economic growth in line with Governments' renewed efforts towards stabilizing the sector, since 1985.

## **2.0: REVIEW OF RELATED LITERATURE**

### **2.1 Conceptual Framework**

#### **2.1.1 Agricultural Output**

Many authors have defined Agriculture and agricultural output in different ways but common among these definitions are:

On the other hands, Hornby (2001) in his own view defined agricultural outputs as including both crops and animals that are grown in large quantity which could serve as food.

Samuelson & Nordhaus (2003) defined agricultural outputs as various useful goods and services produced to be consumed or used for further production. Similarly, agricultural output is usually measured at the market value of final product of crops, fishery and livestock. In addition, they averred that a major element underlying agricultural output (supply) is the cost of production determined by input prices,

technological advance and government policy.

Imahe & Alabi. (2005) described agricultural output as varieties of food and cash crops produced for consumption and export. Among the staple food crops are; cassava, yams, corn, coco-yams, cow-peas, beans, sweet potato, Millet, plantains, bananas, rice, sorghum, and a variety of fruits and vegetables. The leading cash crops are cocoa, citrus, cotton, groundnut, (peanuts) palm oil, palm kernel, benniseed, and rubber. These crops were also major exports products of Nigeria and Ghana in the 1960s and early 1970s. Chief among the export destinations for Nigerian and Ghana agricultural exports are Britain, the United States, Canada, France, and Germany.

The working definition of agricultural output in this study is in line with Ikala (2010), Olarinde, & Abdullahi. (2014);, which views agricultural output as increase in crops, animals, livestock, forestry and fishery production. It is the summation or aggregation of the various outputs from the agricultural sector. Thus, the agricultural sector is a prerequisite for industrialization through increase in outputs, increase in rural incomes and provision of industrial raw materials, provision of a domestic market for industry and above all the release of resources to support the industry. Its importance has therefore necessitated the need for this study.

### **2.1.2 Economic Growth**

Economic growth has been identified as one of the key macroeconomic goals of the society and the issue of growth did not assume prominence until the mid thirties. Several authors have given different definitions to explain the concept and among these authors are:

Todaro (2009) defined economic growth as an expansion of the various systems such as education, agriculture etc without a change in structure. The essential ingredient of Todaro's definition is that, for economic growth to occur, the various institutions or systems in an economy must witness expansion even though their structure remains unchanged.

Solow (1957) defined economic growth to mean more output without a change in technical and institutional arrangement. This implies that Solow threads the path of Todaro, since expansion of various systems is expected to bring more output. To Solow, the structure may change but the technical and institutional arrangement remains the

same.

Peterson & Estenson (2002) on their own viewed economic growth as the expansion of a nation's capability to produce goods and service its people want. Since the productive capability of an economy depends basically on the quantity and the quality of its resources as well as on its level of technical attainment, to them, economic growth involved the process of expanding and improving these determinants of productive capacity and it is a mere expansion of a nation's ability to increase production of goods and services needed by citizens.

Jhingan (2003) described economic growth as the gradual long-run expansion of a nation's capacity to produce goods and services. It is concerned with the slope of potential GDP line- the growth of GDP under the conditions in which unemployment rate is maintained at the natural rate of unemployment. They viewed economic growth as the means by the nation's production possibilities' curve and aggregate supply curve are shifting rightward overtime. Economic growth is not concern with short-run business cycle conditions.

## **2.2. Theoretical Framework**

The theoretical framework adopted in this study is the famous Solow neoclassical growth theory. The relevance of this theory is that, it gives room for modification of the model, secondly it borders on its ability to allow for substitution/argumentation of other input variables into the model or introducing the third independent variable into the model. Thirdly, the model provided a better framework for analyzing the impact of agricultural output in open economy like Nigeria and Ghana

## **2.3 Empirical Review**

Several empirical studies have been carried out on the impact of agricultural output on economic growth. Empirical evidence on the agricultural output-economic growth relationship is diverse, mostly based on cross-sectional studies that often include a sample of both advanced and developing countries.

### **2.3.1 Evidence from Nigeria**

Oyakhilomen & Zibah (2014) in their work agricultural production and economic growth in Nigeria: implication for rural poverty alleviation used time series data to analyse the data unit root tests and the bounds (ARDL) testing approach to cointegration.

The result of the data analysis indicated that agricultural production was significant in influencing the favourable trend of economic growth in Nigeria. Despite the growth of the Nigerian economy, poverty is still on the increase and this calls for a shift from monolithic oil-based economy to a more plural one with agriculture being the lead sector.

Odetola & Etumnu (2013) investigated the contribution of the agricultural sector to economic growth in Nigeria using the growth accounting framework and time series data from 1960 to 2011. They found that the agricultural sector has contributed positively and consistently to economic growth in Nigeria, reaffirming the sector's importance in the economy. The contribution of agriculture to economic growth is further affirmed from a causality test which showed that agriculture growth Granger-causes GDP growth, however no reverse relationship was found. The resilient nature of the sector is evident in its ability to recover more quickly than other sectors from shocks resulting from disruptive events e.g. civil war (1967-70) and economic recession (1981-85) periods. We also find that the crop production subsector contributes the most to agricultural sector growth and that growth in the agriculture sector is overly dependent on growth of the crop production subsector. This indicates the importance of this subsector and probably, lack of attention or investment to the other subsectors.

Oloyede, (2012) analysed the relationship between Agricultural resource and economic growth in Nigeria using Ordinary Least Square regression method. The findings reveal that there exist a positive, cause and effect relationship between agricultural output and gross domestic product in Nigeria.

Oji-Okoro (2011) examined the contribution of agricultural sector on the Nigerian economic development using multiple regression analysis. They found that a positive relationship between Gross Domestic Product (GDP) vis a vis domestic saving, government expenditure on agriculture and foreign direct investment between the period of 1986-2007. It was also revealed in the study that 81% of the variation in GDP could be explained by Domestic Savings, Government Expenditure and Foreign Direct Investment..

### **2.3.2 Evidence from Ghana**

Patrick (2014) studied the analysis of the agricultural sector of Ghana and its economic impact on economic growth. The study used time series (1996-2006) data on

agriculture, service, industry and the various sub-sectors under agriculture, which includes forestry, fishery, crops/ livestock and cocoa. OLS was employed to estimate the respective impact of agriculture, service and industry on GDP growth. The result of the study revealed that agricultural output had a significantly positive impact on Ghana's growth as compared to the other sectors. Agricultural output (0.35); service output (0.28); industrial sector (0.30). In addition, the study further analysed the effect of the various sub sectors under agricultural sector in GDP growth since the agricultural sector contributed more significantly to GDP. At the end of the study cocoa subsector was identified to be vital to economic growth and development in Ghana.

Patrick, Prudence & Attah (2013) examined the contribution of the agricultural, service and industrial sectors to economic growth in Ghana. Time series data from 1966 to 2011 on all the variables of interest was obtained from the World Development Indicators 2012 series. The Ordinary Least Squares estimation technique was used for the analysis. The results showed that a 1% increase in the growth of the agricultural sector will cause GDP growth to increase by 0.45. Also, a 1% increase in the growth of the services sector will lead to 0.38% increase in GDP growth. Finally, a 1% increase in the growth of the industrial sector will bring 0.18% increase in GDP growth. All the explanatory variables are statistically significant at the 5% level of significance. It is concluded that the agriculture sector contributed most to the overall growth.

### **3.0: METHODOLOGY**

**3.1:** The framework of this paper was designed on quantitative plot using VECM model

#### **3.2 Kinds and Sources of Data Required**

The kinds of data required for this study were secondary data. This study used time series data from Nigeria and Ghana. The data required in achieving objective one and two are as follows: Real Gross Domestic Product (RGDP), Agricultural Output (AGO), Industrial Output (IDO), Services output (SVO)

The data were sourced from various publications of the Central Bank of Nigeria(CBN), Bank of Ghana, Statistics Statistical Research Information and Development (SRID), Ghana, Ghana Statistical Service, World Development Indicator/Index (CD -ROM), World Bank Data Base,

#### **3.3 Method of Data Analysis**

The data for this study were analyzed using analytical tools. The analytical tools involve the use of the Augmented Dickey-Fuller (ADF) test, Johansen Co-integration Test and Vector Error Correction Model

### 3.4 Model Specification

**Model:** Comparatively, evaluate the sectoral impact of agriculture sector on growth against other major sectors in Nigeria and to investigate how agricultural sector outputs impact on economic growth in Nigeria as compared to Ghana.

In consonance with the stated objectives and to amplify the analysis, the contribution of the agricultural sector to economic growth in Nigeria and Ghana were measured alongside major sectors of the economy. The dependent variable was transmogrified to RGDP and introduced agriculture, industry, and services as the sectors that form the explanatory variables. The model seeks to investigate how agricultural sector output impact on economic growth in Nigeria and Ghana and comparatively, ascertain which of the two countries is better off in terms of agricultural productivity in the midst of other prevailing sectors of the respective economies. The model is specified in eqn (1.1) below:

$$RGDP = f(AGO, IDO, SVO) \text{-----eqn.11}$$

- Where: RGDP = Real Gross Domestic Product  
 AGO = Agricultural Output  
 IDO = Industrial Output  
 SVO = Services Sector

Representing this relationship in a functional long run framework;

$$RGDP_t = \beta_{10} + \beta_{11}AGO_{t-1} + \beta_{12}IDO_{t-1} + \beta_{13}SVO_{t-1} + U_1 \text{-----eqn.12}$$

$$AGO_t = \beta_{20} + \beta_{21}RGDP_{t-1} + \beta_{22}IDO_{t-1} + \beta_{23}SVO_{t-1} + U_2 \text{-----eqn.13}$$

$$IDO_t = \beta_{30} + \beta_{31}AGO_{t-1} + \beta_{32}RGDP_{t-1} + \beta_{33}SVO_{t-1} + U_3 \text{-----eqn.14}$$

$$SVO_t = \beta_{60} + \beta_{61}AGO_{t-1} + \beta_{62}IDO_{t-1} + \beta_{63}RGDP_{t-1} + U_5 \text{-----eqn.15}$$

Error correction model is a very popular model because it allows for the existence of an underlying or fundamental link between variables (the long-run relationship) as well as for short-run adjustments (i.e. changes) between variables, including adjustments

to achieve the co-integrating relationship. Basically, it is designed for use with non-stationary series that are known to be co-integrated and as well helps to offer a coherent way to combine the long- and short-run effects.

The use of VEC model in this study in achieving two objectives lies in the predictive and forecasting power especially that it is one of the most flexible methods of analysis because it has more efficient coefficient estimates and tool for authenticating results.

The Vector Error Correction Model is given as:

$$\Delta RGDP_{t-1} = \beta_0 + \beta_1 \Delta AGO_{t-1} + \beta_2 \Delta IDO_{t-1} + \beta_3 \Delta SVO_{t-1} + ECM_{t-1} + v_{t-1} \text{-----eqn.16}$$

### 3.5 A priori Expectations

From the empirical models, it is expected that the explanatory variables are expected to have positive relationships with the dependent variables. For model, symbolically, it is expected that:  $\beta_{11} > 0$ ,  $\beta_{12} > 0$ ,  $\beta_{13} > 0$ . Similarly, it is expected that the sectoral contributions from industry, and services would have positive relationships with economic growth in Nigeria and Ghana. In general, it is expected that the output from the agricultural sector has an impact on economic growth in both countries.

## 4.0: DATA PRESENTATION AND ANALYSIS OF RESULTS

### 4.1: Data Presentation

This section presents the data in consonance with the stated objectives of the study.

### 4.2: Data Analysis

#### 4.2.2: Impact of Agricultural Output on Economic Growth in Nigeria and Ghana

##### 4.2.2.1: Unit Root Test (Model 1)

The result of the Augmented Dickey-Fuller (ADF) test is presented below:

**Table 4.8: Stationarity Test (Model)**

Variables	ADF Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	Prob.	Order of Integration
Nigeria						
RGDP	-5.18	-3.69	-2.97	-2.63	0.0002	I(1)

AGO	-4.80	-3.71	-2.98	-2.63	0.0007	I(1)
IDO	-5.65	-3.69	-2.97	-2.63	0.0001	I(1)
SVO	-4.11	-3.70	-2.98	-2.63	0.0024	I(1)
Ghana						
RGDP	-4.80	-3.72	-2.99	-2.63	0.0000	I(1)
AGO	-4.36	-3.70	-2.98	-2.63	0.0000	I(1)
IDO	-4.68	-3.72	-2.99	-2.63	0.0001	I(1)
SVO	-4.33	-3.71	-2.98	-2.63	0.0000	I(1)

*Source: Author's computation from Eviews8*

The ADF statistic values for RGDP, AGO, IDO and SVO are -5.18, -4.80, -5.65, and -4.11 respectively in Nigeria. The associated one sided p-values (for 30 observations) are less than 0.05. The result also shows that the statistic  $t_{\alpha}$  value is greater than the critical values at 1%, 5%, and 10% for all the variables, so we reject the null hypothesis at the conventional test size., the variables are stationary at first difference series.

Thus similarly, in Ghana we reject the null hypothesis at the conventional test size. The ADF statistic values for RGDP, AGO, IDO and SVO are -4.80, -4.36,-4.68, and -4.33 respectively. The associated one sided p-values (for 30 observations) are also less than 0.05. The result also shows that the statistic  $t_{\alpha}$  value is greater than the critical values at 1%, 5%, and 10% for all the variables. Thus, the variables are stationary at first difference series.

#### 4.2.2.2 Johansen Cointegration (Model 1)

The result of the Trace statistic and Max-Eigen statistic are presented in table 4.10 below.

**Table 4.10: Cointegration Test (Model)**

Null Hypothesis	Trace Statistic	0.05 Critical Value	Null Hypothesis	Max-Eigen Statistic	0.05 Critical Value
Nigeria					
$r = 0^*$	57.50361	47.85613	$r = 0^*$	29.46061	27.58434

$r \leq 1$	20.04300	29.79707	$r \leq 1$	10.20596	21.13162
$r \leq 2$	9.837035	15.49471	$r \leq 2$	7.644225	14.26460
$r \leq 3$	2.192810	3.841466	$r \leq 3$	2.192810	3.841466
<i>Note: r represents number of cointegrating vectors. Trace statistic and Max-Eigen statistic indicates 1 cointegrating equations each. * denotes rejection of the hypothesis at the 0.05 level</i>					
Ghana					
$r = 0^*$	48.70624	47.85613	$r = 0^*$	28.64539	27.58434
$r \leq 1$	22.06085	29.79707	$r \leq 1$	11.81809	21.13162
$r \leq 2$	10.24276	15.49471	$r \leq 2$	6.833210	14.26460
$r \leq 3$	3.409554	3.841466	$r \leq 3$	3.409554	3.841466
<i>Note: Trace statistic and Max-Eigen statistic indicates 1 cointegrating equations each.</i>					

**Source:** Author's computation from Eviews8

The Trace test and Max-Eigen value test shows a long run equilibrium relationship between the variables in both Nigeria and Ghana. Thus, the null hypothesis of no co integrating equation is rejected since their statistics are greater than their respective critical values for the co integrating equations at 5% significance level. This implies a stationary linear combination, as such the non stationary time series are co integrated. The application of the VECM technique will therefore yield informative, non-spurious and dependable results.

The long run relationship existing between the variables is shown in the model below:

#### **Estimated Long Run for the Model**

The estimated model is given as:

$$\ln RGDP_t = \beta_{10} + \beta_{11} \ln AGO_{t-1} + \beta_{12} \ln IDO_{t-1} + \beta_{13} \ln SVO_{t-1} + U_1$$

The numerical values of the theoretical parameters are given in table 4.11 below:

**Table 4.11: Long Run for the Model**

	Nigeria			Ghana		
	Coefficient	S. E	T Statistic	Coefficient	S E	T Statistic
C	3.27			6.39		

AGO	-1.21	0.54	2.25	2.52	0.43	5.88
IDO	1.92	0.54	-3.55	0.42	0.12	-3.63
SVO	-0.55	0.21	2.6	1.44	0.29	-4.98

*Source: Author's computation from Eviews8*

Table 4.6 is the long run model showing the sectoral impact of key sectors of Nigeria and Ghana economies. It shows that -1.21 is the coefficient of AGO and tells us that with the influence of IDO and SVO held constant in Nigeria, as AGO increases, say, by one dollar, on average, RGDP goes down by 1.21 dollars (₦193.87). On the other hand, as AGO increases on average (by a dollar) in Ghana, other variables held constant, RGDP increases by \$2.71 (¢10.84). Conversely, the coefficient of SVO suggests that, other variables held constant, an increase in services by one dollar will decrease RGDP in Nigeria by \$0.55 (₦88.12). Contrarily, an increase in SVO by \$1 in Ghana will also increase RGDP proportionately by \$1.44 (¢4).

Conversely, the coefficient of IDO shows that an increase in industrial output in Nigeria, by say, a dollar, will cause real output to increase by \$1.92 (₦307.62). Similarly, in Ghana, an increase in IDO by a dollar will increase real output by 22 cents (¢88). The intercept value of 3.27 in Nigeria means that if the values of AGO, IDO and SVO were fixed at zero, the average level of RGDP in Nigeria would rise by \$3.27 (₦523.92). In Ghana, the result shows that even if the values of AGO, IDO and SVO were fixed at zero, the average level of agricultural output would increase by \$6.39 (¢25.56).

The result further reveals that in Nigeria, the coefficients of AGO and SVO do not conform to a priori expectation having negative signs showing there is an indirect relationship between AGO, SVO and RGDP in Nigeria. The coefficient IDO conforms to a priori expectation displaying the expected positive sign implying there is a direct relationship between IDO and RGDP in Nigeria. More so, the coefficients of AGO, IDO and SVO are statistically significant (i.e.  $\frac{1}{2}b_i > S.E.$ ).

In Ghana, AGO, IDO and SVO conform to a priori expectation. It reveals a positive relationship between AGO, IDO, SVO and RGDP in Ghana. The coefficient of SVO however conforms to a priori expectation and postulates a positive relationship with RGDP. In addition, the coefficients of AGO, IDO and SVO are statistically significant in Ghana.

#### 4.2.2.3 Vector Error Correction Method (Model)

The error correction model is given as:

$$\Delta \ln RGDP_{t-1} = \beta_0 + \beta_1 \Delta \ln AGO_{t-1} + \beta_2 \Delta \ln IDO_{t-1} + \beta_3 \Delta \ln SVO_{t-1} + ECM_{t-1} + v_{t-1}$$

The mathematical coefficients of the stochastic model thus become:

**Table 4.12: Vector Error Correction Model (Model)**

Error Correction Estimates						
	Nigeria			Ghana		
Variable	Coefficient	Standard Error	T statistics	Coefficient	Standard Error	T statistics
ECM	-0.23	0.053	-4.34	-0.04	-0.02	1.79
RGDP	-0.34	0.21	-1.65	0.43	0.24	1.79
D(AGO(-1))	-0.18	0.86	-0.21	-0.06	0.05	-1.20
D(IDO(-1))	-0.19	0.26	-0.73	-0.01	0.04	-0.33
D(SVO(-1))	1.01	1.22	0.83	0.05	0.03	1.77
C	-0.03	0.17	-0.15	0.01	0.005	2.64
Diagnostic Statistics						
R <sup>2</sup>	0.84			R <sup>2</sup>	0.82	
$\bar{R}^2$	0.77			$\bar{R}^2$	0.69	
F Statistic	8.4			F Statistic	7.2	
F <sub>0.05</sub>	2.71			F <sub>0.05</sub>	2.71	

*Source: Author's computation from Eviews8*

The table above shows the short run estimates of the VEC model used in estimating the impact of the major sectors in Nigeria and Ghana on economic growth. In both Nigeria and Ghana, the coefficients of SVO display sign that conforms to a priori expectation while the coefficients of AGO and IDO does not. Furthermore, unlike the long run model which shows that all the variables are statistically significant, all the parameter estimates are not statistically significant in the short run in Nigeria and Ghana.

In Nigeria the adjusted  $R^2$  value of 0.77 means that about 77% of the variations in economic growth is explained by AGO, IDO and SVO. This is high considering that the maximum value of  $R^2$  can at most be 1. The coefficient of about 0.77 shows that agricultural output, industrial output, services output and economic growth are strongly positively correlated. The same is the case in Ghana which shows that 82% of the variations in RGDP is accounted for by AGO, IDO and SVO. The adjusted  $R^2$  of 0.69 shows a strongly positive correlation between the dependent and independent variables.

The study also finds out that AGO, IDO and SVO are jointly significant in Nigeria and Ghana. The F statistic shows the overall significance of the estimated model in both countries. The result reveals that the log likelihood of obtaining an F value of as much as 8.4 (Nigeria) or 7.2 (Ghana) or greater is simultaneously less than zero, leading to the rejection of the hypothesis that together AGO, IDO and SVO are jointly irrelevant in explaining changes in economic growth in Nigeria and Ghana. This buttresses the overall goodness of fit of the models. Thus, the overall prediction power of the econometric model is statistically significant.

The coefficient of the error correction term is statistically significant in both Nigeria and Ghana. In both countries this coefficients are correctly signed. In Nigeria, the magnitude of -0.23 indicates that if there is any deviation, the long run equilibrium is adjusted speedily where about 23% of the disequilibrium may be removed in each period. This shows that the speed of adjustment to where RGDP will equilibrate even when there is initial disequilibrium is at the rate of 23%. In Ghana, the magnitude of -0.04 shows that the speed of adjustment to where RGDP will equilibrate even when there is initial disequilibrium is 4% which is slower than that of Nigeria. This implies that in Ghana, if there is any deviation, the long run equilibrium is adjusted slowly where about 4% of the disequilibrium may be removed in each period.

The result also reveals that in the short run, a unit change in AGO in the previous year will lead to an decrease in RGDP by 18 cents (₦28.84) in Nigeria and 0.6 cents (¢0.24) in Ghana. Similarly, a unit change in IDO in the previous year will cause RGDP to decrease by \$0.19 (₦30.44) and \$0.01 (¢0.04) in Ghana. Conversely, a unit change in the previous year in SVO will increase RGDP by \$1.01 (₦161.82) in Nigeria and by \$0.05 (¢0.2) in Ghana.

### 4.2.3 Test of Hypotheses

The hypothesis as stated earlier in the introductory part of this work is as follows:

#### **Hypothesis 1**

H<sub>01</sub>: Agricultural sector outputs have no significant impact on economic growth as compared to other major sector's output in Nigeria and Ghana

#### **Hypothesis 2**

H<sub>02</sub>: Agricultural outputs have no significant impact on economic growth in Nigeria as compared to Ghana.

#### **Decision Rule**

If  $|t_{b_i}| > S.E.$ , we reject the null hypotheses and accept the alternative, otherwise we accept the null hypothesis and reject the alternative.

#### **Model**

Based on the decision rule, the coefficients of AGO, IDO and SVO are statistically significant in Nigeria. In Ghana, the same is the case, as the coefficients of AGO, IDO and SVO are statistically significant while that of IDO is not statistically significant. Comparatively, the models also revealed that agricultural output is significant in stimulating growth in Ghana and Nigeria. However, the agricultural sector in Ghana thrives better in accelerating growth than Nigeria agricultural sector. Therefore, we accept the alternative hypothesis and conclude that there exists a significant difference in the sectoral impact of agricultural output to economic growth to impact of other major sectors in Nigeria and Ghana and reject the null hypothesis that there no exists a significant impact of agricultural output on economic growth in Nigeria as compared to Ghana.

### 4.3 Discussion of Findings

The first objective was to analyse the impact of the agricultural sector on economic growth in relation to other major sectors in Nigeria and Ghana. The result revealed that in Nigeria, the coefficients of AGO and SVO do not conform to a priori showing there is an indirect relationship between AGO, SVO and RGDP in Nigeria. The coefficient IDO conforms to a priori implying there is a direct relationship between IDO and RGDP in Nigeria, which has been majorly influenced by the oil sector. The mismatch in the sign of AGO can be explained by the neglect of the agricultural sector in Nigeria after the oil

boom. Services became lucrative in Nigeria in the light of the rebasing exercise which saw a surge in output from the sector. Prior to that time, its impact on economic growth was undermined which may explain the negative sign.

In Ghana, AGO, IDO and SVO conforms to a priori expectation implying a positive relationship between AGO, IDO and SVO and RGDP in Ghana. The positive sign shows a high level of interdependency between the industrial and agricultural sector in Ghana. In addition, the Ghanaian sector is diversifying away from the agricultural sector which may explain the robustness of the sectors. The need for services is on the increasing need and this has spurred its demand, which explains the positive relationship it has with economic growth in Ghana. Comparatively, on the sectoral impact, the industrial sector performed better in Nigeria than in Ghana. However, the agricultural sector performed better in Ghana than in Nigeria. This shows that Ghana's utilization of inputs has translated into improved agricultural output which in turn has stimulated economic growth. However, the Nigerian government has not managed to effectively initiate the needed change to boost output in the sector. Based on the result, the industrial sector remains the sector with the highest potential for growth in Nigeria while in Ghana it remains the agricultural sector.

The second objective was to investigate how agricultural sector output impact on economic growth in Nigeria as compared to Ghana, the results shows that, the coefficients of the three major sectors in Nigeria are given as: AGO (-1.97), IDO (2.21) and SVO (-1.81) while in Ghana the coefficients are AGO (2.52), IDO (0.42) and SVO (1.44). The result revealed that in terms of contribution to GDP, agriculture contributed to Ghana GDP than service sector other sectors followed by industrial sector while in Nigeria the contribution of agriculture to GDP is insignificant compared to other sectors.

## 5.1 Summary

This paper aimed at investigating the impact of agricultural output on economic growth in Nigeria and Ghana. The study built one model to give empirical content to the main objectives and hypothesis testing. As a result of the techniques employed the study found out that;

- Agricultural outputs have significant impact on economic in Ghana than Nigeria. Which implies that agricultural sector in Ghana thrives better in accelerating economic growth than the agricultural sector in Nigeria.
- In Nigeria, the industrial sector thrives better than the agricultural and services sectors. The indirect relationship between both the agricultural and services sectors and economic growth shows lack of interdependency between the two sectors. This is explained by the transfer of resources from the agricultural sector to the industrial sector accounting for the mismatch. Based on the results, the industrial sector remains the sector with the highest potential for growth in Nigeria while in Ghana it remains the agricultural sector.

## 5.2 **Conclusion**

This study concludes that agricultural outputs have significant impact on economic growth in Ghana within the study period while in Nigeria the impact of agricultural output is not significant. On the sectoral analysis it was revealed that the industrial and services sector contribute more to growth than agriculture in Nigeria as compared to Ghana.

## 5.3 **Recommendations**

Based on the findings of the study, the following recommendations are hereby made:

- Given the potential of the agricultural sector, Commercial Banks, Bank of Agriculture and other financial institutions in Nigeria and Ghana should channel more loans and credit facilities to the sector in order to encourage farmers to increase output through improved seedlings, adequate manure and proper land usage. It is also recommended that the condition for loans should be relaxed and the interest rate on loans should be reduced to enable farmers to obtain loans even without collateral securities.
- The Ghanaian government should provide basic infrastructure in the industrial sector to support and harness the output derived from the agricultural sector to ensure interdependency between the sectors.

- Furthermore, the Ghanaian government should channel the surplus labour from agricultural sector into industry and services in order to boost sustained economic growth. In addition, both the Nigerian and Ghanaian government should provide more tractors and agricultural machineries to replace labour and boost output in the sector.
- Finally, policies aimed at increasing the quality of agricultural outputs should be initiated, implemented and used as major tools that would precipitate economic growth in Nigeria and Ghana. More farm implements and inputs should be provided to boost output growth.

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## **Nigerian Plant Resources, an incredible generosity with an incredible responsibility**

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### **ABSTRACT**

Nigeria is a physically and climatically diverse country that has been endowed with substantial plant resources. The natural vegetation varies from rain forest to savanna with nine distinct ecological zones which permit the growth of a wide variety of crops. The country is generously blessed with a lot of plant resources to the extent that, there will be no reason whatsoever to live in hunger or suffering. This magnanimity is an incredible generosity of Mother Nature which carries with it an equally incredible responsibility. This review paper attempts to highlight the value and incalculable magnanimity of Mother Nature in Nigerian Plant genetic resources. It also discusses the need to utilize the God-given plant genetic resources with responsibility and wise exploitation. Apparently, there is need for the scientific research community in every country to wake up to this reality and be engaged in not just knowing their heritage in plant genetic resources but also to do what is necessary to ensure food security in their country.

**Keywords:** Plant genetic resources, Natural vegetation, Incredible generosity, Incredible responsibility, Wise exploitation, Food security

### **INTRODUCTION**

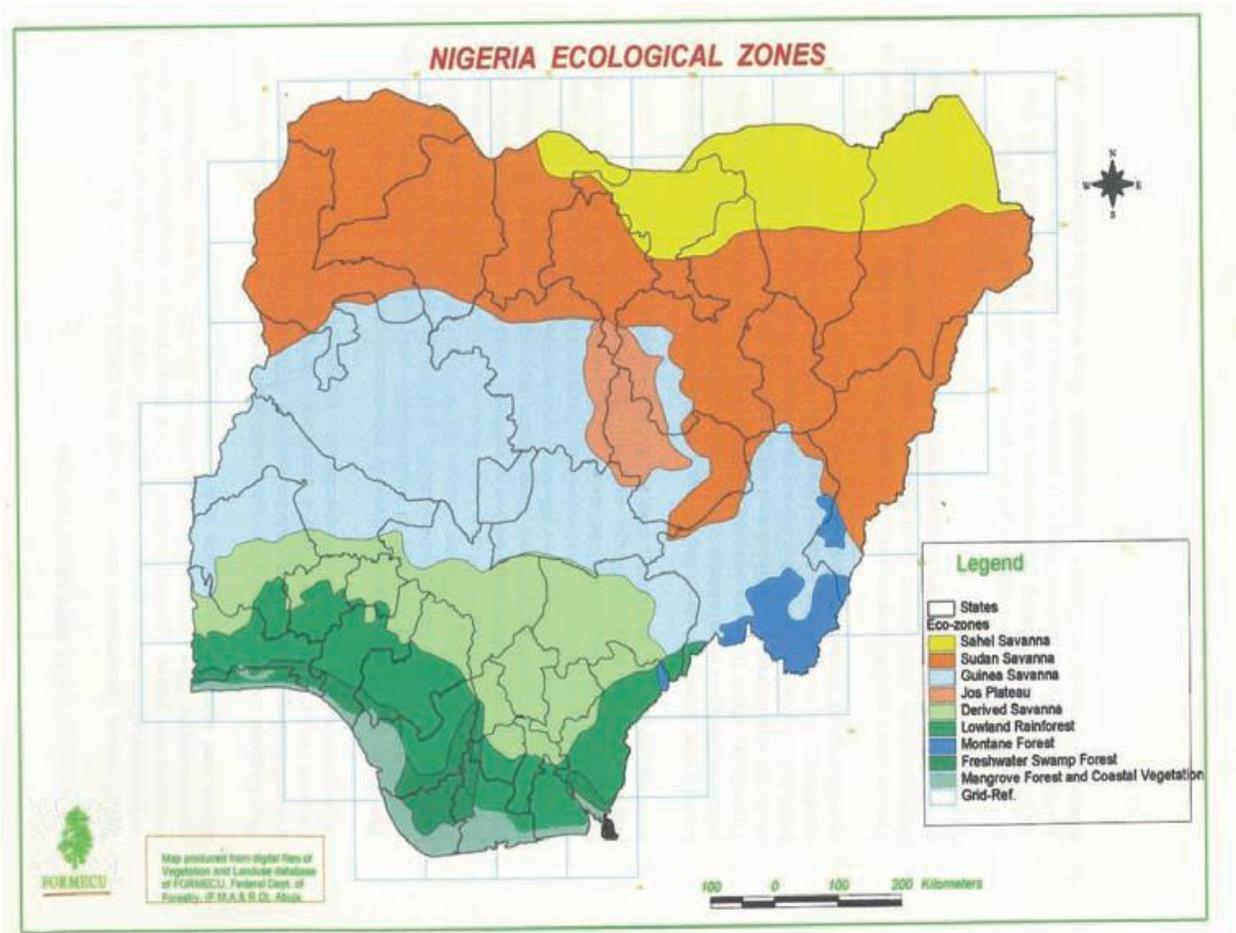
All life on earth depends on plants. Without their capacities to fix the sun's energy by means of chlorophyll, man and all other species of animals would die. Besides, plants are sources of our basic needs: food, cloth, house and medicine. They account for over 80 percent of the human diet (FAO, 2013). The plant resources form an integral part of a huge inter-dependent system that encompasses the physical components and the biological community of life (Malik and Singh, 2006). Plant genetic resources can be described as any material of plant origin that contains functional units of heredity of actual or potential use. It refers to the reproductive or vegetative propagating materials of the following categories of plants i) cultivated varieties (cultivars) in current use and newly developed varieties ii) obsolete cultivars iii) primitive cultivars or land races iv) wild and weed species, near relative of cultivated varieties and v) special genetic stocks including elite and current breeders lines and mutants (FAO, 1993). They are genetic materials of plant origin of actual or potential value for food and agriculture, e.g. seeds,

tubers, mature plants etc. These include all our agricultural crops and some of their wild relatives which are often of valuable traits. They are the raw materials that farmers and plant breeders use to improve the quality and productivity of crops. These resources according to FAO (2013) are generally referred to as germplasm and the lifeblood of plant breeding. They are a heritage of mankind to be preserved and to be freely available for use for the benefit of present and future generations. Generally speaking, plant resources are the backbones of agriculture which play a positive and unique role in the development of new cultivars including the restructuring of existing ones (Ishaq *et al.*, 2004). This paper attempts to highlight the value and incalculable magnanimity of Mother Nature in Nigerian Plant genetic resources. It also discusses the need to utilize the God-given plant genetic resources with responsibility.

### **NIGERIAN PLANT GENETIC RESOURCES: – Nature’s Incredible Generosity**

Nigeria is a physically and climatically diverse country that has been endowed with substantial plant resources. According to National center for Genetic resources and Biotechnology NCGRB (2008), the natural vegetation in Nigeria varies from rain forest to savanna with nine distinct ecological zones (Figure 1) which, due to similarity of characteristics, has been streamlined into five namely, (i) sahel/sudan savanna, (ii) guinea savanna, (iii) derived savanna, (iv) lowland rainforest/montane forest and (v) freshwater swamp forest/mangrove forest and coastal vegetation. Nigerian physical and climatic diversity permits the growth of a wide variety of crops. The Federal Ministry of Environment (2006) reported that 7,895 plant species from 338 families and 2,215 genera have been identified in Nigeria (Table 1). These include a wide range of crops in which we enjoy comparative advantage. The fertility of the Nigerian soil and the wide range of variations in climate has also allowed the production of a variety of crops (Durugbo *et al.*, 2012). The major staple food crops in the country include Yam, Cassava, maize, Plantain Rice, Sorghum, Millet and a variety of fruits and vegetables. Currently, Nigeria is one of the world’s leading producers of cowpea, cassava and yam. According to NCGRB (2008), the leading cash crops are Cocoa, Oranges, Cotton, Groundnuts, Palm oil, Palm kernel, Beans seeds and Rubber. Certainly God has blessed our country with a variety of plants that can make our existence much better and perhaps longer. The huge genetic

resources that we have in the country are meant for our enjoyment, progress, daily survival and livelihood(Kutama *et al.*, 2015; Titus *et al.*, 2018). Unfortunately, we have utilized only very little out of the array of these plant genetic resources. Some of those we have explored for food are listed in Table 2 and Plates 1-32



**Figure 1: A map of Nigeria showing the nine ecological zones in the country.**

**Source: NCGRB (2008)**

**Table 1 : Inventory of Plant Taxa in Nigeria**

<b>Group of plants</b>	<b>No of families</b>	<b>No of genera</b>	<b>No of Species</b>
Algae	67	281	1335
Lichens	-	14	17
Fungi (Mushrooms)	26	60	134
Mosses	-	13	16
Liverworts	-	16	6
Pteridophyte	27	64	165
Gymnosperms	2	3	5
Chlamydosperms	2	2	6
Monocotyledons	42	376	1575
Dicotyledon	172	1396	4636
<b>Total</b>	<b>338</b>	<b>2215</b>	<b>7895</b>

Source: Nigeria's First National Biodiversity Report, Fm Env. (2006)

**Table 2: Plants being used for Food in Nigeria**

<b>S/N</b>	<b>Plant</b>	<b>Common name</b>	<b>Uses</b>
A	<b>TUBERS</b>		
1	<i>Manihot esculentus</i>	Cassava	Root tuber, processed into flour, (elubo), pure starch fufu or eaten boiled, used as industrial major starchy foods, e.g. garri raw materials bakery
2	<i>Dioscorea spp</i>	yam	Stem tuber, processed into major starchy foods e.g. yam flour or boiled and eaten directly or pounded (pounded yam).

3	<i>Ipomeae batatas</i>	Sweet potato	Root tuber, boiled and eaten directly or pounded with yam or fried in oil.
4	<i>Solanum tuberosum</i>	Irish potato	Stem tuber, used as a carbohydrate food fried or flaked. and eaten throughout Nigeria in different forms, boiled, mashed
5	<i>Colocacia esculentus</i>	Cocoyam	Root tuber/Rhizome, processed into different carbohydrate foods.

**B CEREALS**

1	<i>Zea mays</i>	maize (corn)	Grains are eaten boiled or roasted, can be processed into different food items, as feed for livestock, also as industrial raw material.
2	<i>Sorghum bicolor</i>	Guinea corn	Grains are eaten boiled, roasted or processed into different food items; also as industrial raw materials in breweries.
3	<i>Pennisetum americanum</i> <i>P. glaucum</i>	millet	Grains are used in various forms of staple food
4	<i>Tritium aestivum</i>	Bread wheat	Main source of flour bread, cake, and other confectionary.
5	<i>Oryza spp.</i>	Rice	Rice is a staple food, a major source of carbohydrate food in Nigeria

**C FOOD LEGUMES**

1	<i>Vigna unguiculata</i>	Cowpea	The most important legume in Nigeria, cultivated- for food and forage
2	<i>Glycine max</i>	Soya bean	Soya bean is an important source of plant protein and is processed to serve as food supplements as soya milk, soyabean or to fortify other food products such as soyaogi, soya feeds formulation. infants food and livestock.

3	<i>Arachis hypogea</i>	Groundnut/ Peanut	Groundnut is very rich in plant protein and source of rich vegetable oil. The nuts are processed into various food items and soup, and is an important component of livestock feeds
4	<i>Parkia biglobosa</i>	Locus bean tree	Friut pulp is eaten and used in a local brew. The seeds are processed into condiment called iru (Yoruba) or Dadawa in Hausa

**D OIL CROPS**

1	<i>Elaeis guinensis</i>	Oil palm	Source of red oil and kernel
2	<i>Sesamum indicum</i>	Sesame (Beniseed)	source of highly priced rich vegetable oil,
3	<i>Citrullus lanatus</i>	Egusi, melon	Very rich in vegetable oil Seeds also used in soup preparations
4	<i>Cocos nucifera</i>	Coconut	Source of coconut oil
5	<i>Ricinus communis</i>	Castor oil	Source of castor oil
6	<i>Gossypium</i> spp.	Cotton	Source of cotton seed oil

**E PLANT- BASED SWEETNERS**

1	<i>Saccharium officinarium</i>	Sugarcane	Main source of the Raw material for the sugar industry.
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**F HORTICULTURAL CROPS**

1	<i>Capsicum</i> spp.	Pepper	Pepper is a major component of Nigerian food with different degree of purgency
2	<i>Lycopersicon esculentus</i>	Tomato	Tomato is an important component of Nigerian food.
3	<i>Alium cepa</i>	Onion	Onion is an important food.
4	<i>Amaranthus</i> spp.	Amaranthus, Tete	Amaranthus is an important leaf

		(Yoruba)	vegetable
5	<i>Albelmoschus esculentus</i>	Okra Ila (Yoruba)	Okra is an important fruit
6	<i>Corchorus</i> spp.	Jute Ewedu (Yoruba)	<i>Corchorus olitorius</i> is an important leaf vegetable.
7	<i>Solanum raddi</i>	Egg plant (indigo)	The fruit of garden egg is eaten raw or cooked
8	<i>Musa</i> spp.	Plantain	Fruit rich in iron
9	<i>Telfairia occidentalis</i>	Ugu (Ibo)	Leafy vegetable, rich in iron.
10	<i>Carica papaya</i>	Pawpaw	This is a fruit vegetable
11	<i>Ananas cosmotus</i>	Pineapple	An important fruit and raw materials for juice Industry
12	<i>Daucus carota</i>	Carrot	An important root vegetable.
13	<i>Pisidium guajava</i>	Guava	Fruit is eaten fresh and as component of jam
14	<i>Cirtus sinensis</i>	Orange	Juice taken fresh or extracted and used in beverages
15	<i>Mangifera indica</i>	Mango	Fruit is eaten fresh or processed into beverages.
16	<i>Anacardium occidentale</i>	Cashew	Juice is taken directly or processed into beverage. The nuts are also eaten
17	<i>Pyrus communis</i>	Pear	The fruit is delicious
18	<i>Ocimum gratissimum</i>	(Yoruba) Efinrin	The spicy leaves are eaten as vegetable or used to ganish soups.
19	<i>Cucumis sativus</i>	Cucumber	Fruit vegetable.
20	<i>Latuca sativa</i>	Lettuce	Leaf vegetable
21	<i>Celosia</i> spp;	Ajefowo (Yor )Sokoyokoto	Leaf vegetable
22	<i>Vernonia amygdalina</i>	Ewuro (Yoruba) Bitter leaf	Leaf vegetable
23	<i>Hibiscus</i> spp	Isapa,Zobo plant	Leaf vegetable.

24 *Tetracarpidium*  
*conophorum*

Awusa (Yor)

The cotyledons are proteinous and eaten cooked.

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Source: NCGRB (2008)



Plate 1: Seeds and fruits of Guinea Corn (*Sorghum bicolor*)



Plate 2: Fruit and seeds of Millet (*Pennisetum americanum*)



Plate 3: Seeds and fruit of Maize (*Zea mays* L.) plant



Plate 4: Fruiting Rice (*Oryza* spp) plants



Plate5: Fruits and seeds of Cowpea (*Vigna unguiculata* (L) Walp)



Plate 6: Leaves and tubers of Cassava (*Manihot esculanta*, crantz)



Plate 7: Yam (*Dioscorea rotundata*) tubers and seed yam



Plate 8: Tubers and shoots of Cocoyam (*Colocacia esculentus*)



Plate 9: Seeds and Shoot of Groundnut (*Arachis hypogea*)



Plate 10: Fruit of *Parkia biglobosa*



Plate 11: Fruit of Mango (*Mangifera indica*)



Plate 12: Fruit of Cashew (*Anacardium occidentale*)



Plate 13: Fruit of Orange (*Citrus sinensis*)



Plate 14: Fruit of Tomato (*Lycopersicon esculentus*)

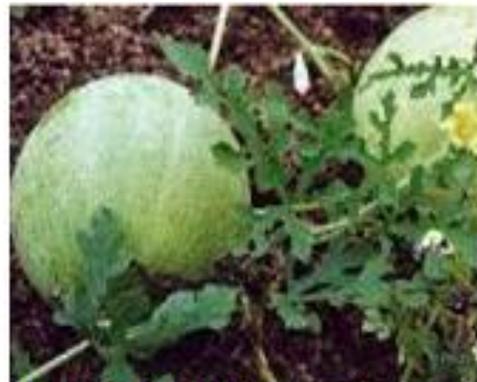


Plate 15: Fruit of Melon (*Citrullus lanatus*)



Plate 16: Fruit of Pepper



Plate 17: Plants and seeds of Bambara nut (*Vigna subterranea*)



Plate 18: Shoot, Fruit Pods and Seeds of *Moringa oleifera*





Plate 19: Fruits and Seeds of *Garcinia kola* (Bitter kola)



Plate 20: Fruits and Seeds of *Chrysophyllum albidum* (African Star apple)



Plate 21: Fruits and Seeds of *Treculia africana* (African Bread fruit)



Plate 22: Fruits and Seeds of *Irvingia gabonensis* (African Bush Mang)



Plate 23: Fruits and Seeds of *Dacryodes edulis* (African bush butter)



Plate 24: Fruit head of *Annona muricata* (Soursop Fruit)

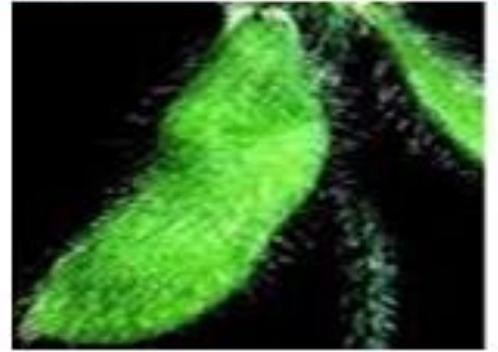


Plate 25 : Fruit and shoot of Soyabean (*Glycine max*)



Plate 26: Sugarcane (*Saccharium officinarium*) stems and leaves



Plate 27: Cucumber (*Cucumis sativus*) fruits and leaves



Plate 28: The Jute (*Corchorus* spp) plant



Plate 29: Onion (*Allium cepa*) leaves and bulb



Plate 30: Banana (*Musa* spp) fruits and shoots



Plate 31: Okra (*Albimorichus esculentus*) leaves and fruits



Plate 32: Flowers fruits and seeds of Sesame (*Sesamum indicum*)

Sources of Plates: Falusi *et al.*( 2001) Falusi and Salako,(2002); Falusi *et al.* (2002); Ndukwu(2012)

Apart from these plants, Nigeria also has a wide diversity of other plant species. The country is very rich in plant resources which exist in wild forms in plants' natural habitats and in diverse crop landraces/ecotypes/cultivars. They include grasses and many browse species. Nigeria has a list of 2, 200 verified nutritious species which include 600 grasses, 540 herbaceous legumes and 380 browse species and over 600 others of lower values (NCGRB, 2008; Amusa *et al.*, 2010; Monpara, 2016). Most of these species are components of the high forest, guinea savanna, sudan savanna and some very hardy plants in the sahelian zone. The number of non-domesticated plants that has been collected from the wild to bridge hunger gaps is far more diverse.

From the incalculable magnanimity of Mother Nature to Nigeria, we can unanimously attest that the country's plant genetic resources is indeed an INCREDIBLE GENEROSITY. This generosity is thrilling, exhilarating and bewildering. It is simply a

wonder and a marvel. I believe it is God's incredible gifts that need to be explored for food security .

### **OUR INCREDIBLE RESPONSIBILITY**

The nature's intention and generosity is for us to use plant genetic resources to ensure our future survival. It is, therefore our responsibility to be wise on the exploitation of the resources. According to Ndukwu (2012),the magnanimity and incredible generosity of Mother Nature carries with it an equally incredible responsibility. *“And the Lord God took the man, and put him into the Garden of Eden ..... to DRESS IT and to KEEP IT .....*” **Genesis 2:15** .Permit me to inform us that we may not have an Eden in that original sense anymore. However, each of us has been handed over an Eden of a sort. Our own Eden could be our University or our village, compound, estate or homestead garden, depending on our sphere of influence. I wish to inform all of us that those words ‘DRESS IT’ and ‘KEEP IT’ are heavy, if we understand them. It requires our greatest RESONSIBILITY. We may sound religious about this. We may trivialize and gloss over it. But I assure us that if we ignore them, the implications will not be good enough. This is because our very lives, livelihood and continued existence in the beautiful EDEN – planet earth is inextricably hinged on how we utilize our God-given plant genetic resources. It is this dynamic approach that has guided the title of this paper.

It is our collective responsibility to conserve and make proper good use of the generous gift of God in plant genetic resources. There are several of the benefits of these plants that are hidden in deep secrets. *‘It is the glory of God to conceal a thing; but the honour of kings (men) is to search out a matter’..... Proverbs 25; 2*, Part of our responsibilities and indeed honour is to discover, and wisely exploit them for our advantages. If we humble ourselves and quietly approach Nature, we will be shown some of these deep secrets. This is the basis of all human ingenuity and inventions.

### **CONCLUSION**

God has generously blessed our country with a lot of plant resources and we certainly have no reason whatsoever to live in hunger or suffering. Our country is endowed with a

wide diversity of plant resources that we can harness to ensure food security. This magnanimity, to me is an incredible generosity of Mother Nature. It also carries with it an equally incredible responsibility. Therefore the scientific research community needs to wake up to this reality and be engaged in not just knowing these heritage but also engaged in preserving it to ensure food security for this generation and the unborn generations.

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# Climate Change and Maize Yield in Kenya: An Econometric Analysis

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## ABSTRACT

The agricultural sector plays a critical role in the Kenyan economy in terms of employment and food security. However, the sector and particularly crop farming is vulnerable to climate change, given that rain fed agriculture accounts for approximately 98 percent of agricultural activities. Crop farming in Kenya has limited diversification and maize production is critical. Maize production forms a strong base to food security, employment, income generation, poverty alleviation, as well as economic growth and development. This notwithstanding, maize production has greatly fluctuated leaving about 40 percent of population food insecure. Maize production largely depends on climate variables and is highly sensitive to climate change. Thus, it is important to understand the effects of the changing temperature and rainfall patterns, to which this study contributes by analyzing the marginal effects of climate change on maize yield. The study adopted an econometric modeling approach using data for the period between 1970 and 2014. The study findings show that climate change has adverse effects on maize yield. In addition, the study finds a nonlinear relationship between maize yield and climatic variables. However, the direction and magnitude of the effects vary depending on the season. Hence, there is need to elevate the potential of rain fed agriculture in the midst of the risks posed by climate change.

Keywords: Maize Yield, Temperature, Rainfall, Temperature Variability, Rainfall Variability and Climate Change.

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## 1. INTRODUCTION

Climate change threatens the achievement of sustainable development goals aimed at

ending extreme poverty in all forms by 2030; end hunger, achieve food security and improved nutrition and promote sustainable agriculture and as well, promote sustained, inclusive and sustainable economic growth (United Nations Development Programme (UNDP), 2015). These issues are of great concern to sub-Saharan Africa where majority of the people depend on rainfed agriculture to support their livelihoods. Consequently, the effects of climate change in the agricultural sector and more specifically crop production is of great concern.

According to Intergovernmental Panel on Climate Change ((IPCC), 2014: 120), "Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer". Climate change has a direct influence on quality and quantity of agricultural crop production. The climate of an area is highly correlated to the crops cultivated and thus predictability of climate is imperative for planning of farm operations (Sowunmi, 2010). Climate change is expected to increase with global warming with the average temperatures expected to increase by between 1.4° Celsius (C) and 6.4° C by 2100. This is above threshold limit of 3°C beyond which it becomes impracticable to avoid dangerous interference with the global climatic system (World Trade Organization (WTO)&United Nations Environment Programme (UNEP), 2009). This average is anticipated to be higher throughout Africa, where average temperature is projected to rise 1.5 times more compared to the global level. Countries near the equator like Kenya, many of which are developing, are likely to experience unbearable heat, more frequent droughts and ruined crops, exacerbating the hunger crisis (Food and Agriculture Organization (FAO), 2012; WTO & UNEP, 2009). The increasingly irregular and erratic nature of weather conditions places more burden on food security and rural livelihoods (FAO, 2009).

In Kenya, crop production is a major source of livelihood for most rural communities practicing smallholder farming. It is mainly rain fed and changes in rainfall and temperature patterns are expected to affect its potential (Stern, 2007). Indeed, Kenya has experienced patterns of climate changes, with El Nino and La Nina episodes being most severe (Stockholm Environmental Institute (SEI), 2009). As well, temperatures are

expected to increase by about 4°C and variability in rainfall expected to rise up to 20 percent by 2030. These changes are likely to affect the optimal conditions required at each stage of crop growth and development and consequently affect the quantity and quality of harvested crops (Stern, 2007).

Crop farming in Kenya has limited diversification and maize serves as the main staple and key to food security (UNDP, 2002; Alila&Otieno, 2006). Thus, to continue supporting the livelihood of a rapidly growing population, there is need to have a sustainable increase in maize production. Although, economic incentives are provided to farmers to improve crop production, climate change is likely to undermine these efforts, threatening the livelihood of over 85 percent of Kenyan population. It is in the light of the importance of maize in Kenya's economy and to the livelihoods of majority of rural inhabitants that this study seeks to empirically determine the effects of climate change on maize yield using econometric analysis and thereof draw implications on food security as maize supply is to a large extent synonymous to food security in Kenya.

### **1.1 Climate Change in Kenya**

From the 1960s, Kenya has generally experienced increasing temperatures at an average rate of 0.21°C per decade with trends in both minimum and maximum temperatures depicting a general warming over time. Annual highest rainfall events show a falling trend for the 24 hour intense rainfall and the amount recorded in the long rain season from 1960 to 2014 (Republic of Kenya, 2015). Figure 1 and 2 displays the year to year variability of temperature and rainfall in maize growing areas in Kenya.

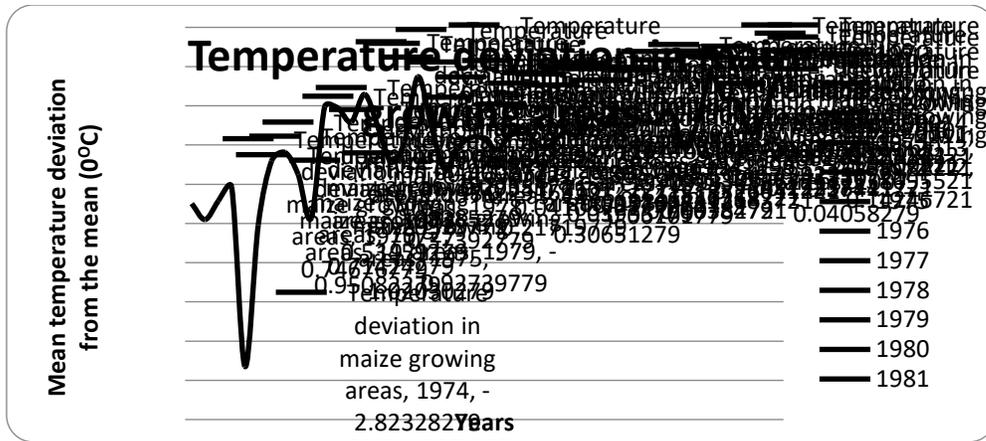


Figure 1: Annual Mean Temperature Variations in Maize Growing Areas in Kenya (1970-2014)

Source: Kenya Meteorological Department

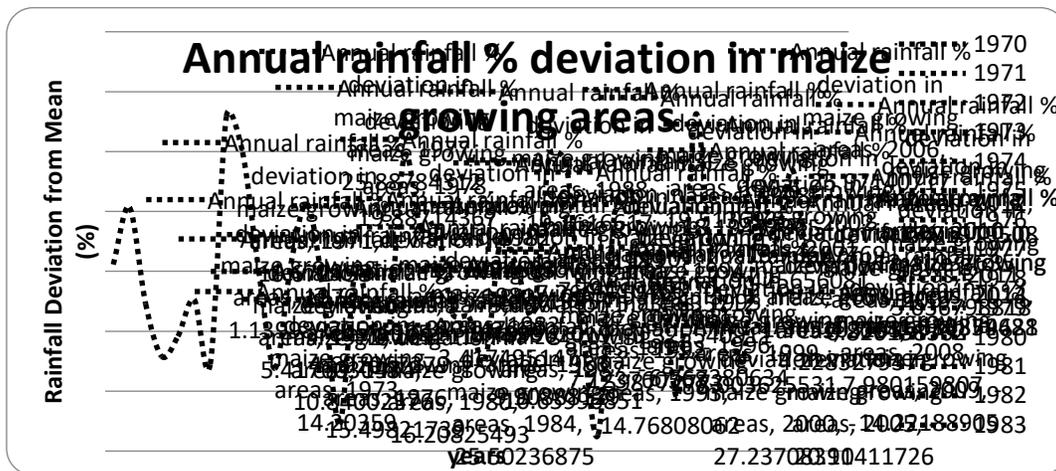


Figure 2: Annual Rainfall Deviations (%) From the Mean in Maize Growing Areas in Kenya (1970-2014)

Source: Kenya Meteorological Department

The temperature and rainfall variations in maize growing areas are computed using data recorded in various weather stations, in areas where there is high potential for maize farming. These stations include: Kitale, Nyahururu, Nyeri, Thika, Narok, Nakuru, Kabete, Machakos, Kakamega, Meru, Embu, Kisii, Kericho and Eldoret

The year to year variation of average temperature for the period 1970 to 2014 shows a

slight increase in temperature with fluctuations of up to minus 2.8°C and plus 1°C. The deviation of rainfall amount from the mean annual rainfall for the period between 1970 and 2014 show drought and flood conditions in the crop growing regions. The fluctuations depict occurrence of extreme weather events that have been witnessed in Kenya. For instance, severe droughts occurred in 1971/73, 1983/84, 1991/92, 2004-2006, and 2008-2010. As well, flooding occurred in 1997/98 and 2002, which is closely linked to El Nino events with a severe frost occurring in 2012 (Rarieya *et al.*, 2009; KIPPRA, 2013).

Projections of mean rainfall indicate increases in annual rainfall in Kenya at -3 to +49mm per month for the months of October, November and December (OND) and larger proportional changes in January and February (JF) at -7 to +89% by 2030. The unpredictability of Kenya's rainfall and the tendency for it to fall heavily during short periods is likely to cause problems by increasing the occurrences of heavy rainfall periods and flooding. As well, temperature increase is expected to exacerbate the drought conditions (Osbaahr & Viner, 2006; McSweeney, 2010).

## **1.2 Agriculture sector in Kenya**

The importance of agricultural sector and the ensuing vulnerability, more so in Kenya, makes it a key concern for this study. The agricultural sector in Kenya contributes to 30 percent of Kenya's Gross Domestic Product (GDP) and employs over 40 percent of total population. Additionally, over 80 percent of rural people depend on agriculture for their livelihood. It also accounts for more than 60 percent of export earnings and about 45 percent of government revenue. Further, the sector is estimated to have an indirect contribution of nearly 27 percent of GDP through linkages with manufacturing, distribution and other service related sectors. Imperatively, the agricultural sector forms a strong base for food security, creation of employment and generation of foreign exchange and it is central to the country's development strategy given that majority of industries in Kenya are agro-based (Republic of Kenya, 2005; 2011, 2016).

Rain fed agriculture accounts for approximately 98 percent of agricultural activities in Kenya (UNEP, 2009). This makes the sector highly vulnerable to increasing

temperatures, droughts, floods and changing rainfall patterns. The effects threaten livelihood of farmers and are likely to influence farming decisions. The performance of the agricultural sector mainly depends on crop production, which is largely dependent on climate conditions. Evidently, the sector's growth rate has been fluctuating over the years. This has been attributed to over reliance on rain fed agriculture, which is prone to erratic weather conditions plus high cost of agricultural production (Republic of Kenya, 2012; 2014; Alila&Otieno, 2006; KIPPRA, 2013).

### **1.3 Maize Production in Kenya**

In Kenya, maize (*Zea Mays*) constitutes the most important staple food. Its contribution to consumption and income is important and an anchor to food security. Maize is a cereal crop grown in a range of agro- ecological environments. Globally, there are over 50 species of maize consisting of different colors, texture, sizes and shapes with yellow and white species being the most common preferred types. In Kenya, maize farming is spread all over the country from 0- 2200 meters above sea level (masl), facilitated by hybrids and composites developed for different ecological zones by the national maize breeding program (Mbithi, 2000).

Maize crop performs best in well drained and well aerated loam soils with a pH of 5.5 -7 and is intolerant to water logging. Low production is recorded in very high and low altitudes with optimum temperatures for good yield ranging between 18 to 30°C. Cold conditions lengthen the maturity periods with high temperatures reducing production. Maize grows well with 600-900 mm of rainfall, which should be well distributed throughout the growing period. Rainfall is most critical at flowering and silking stage. Drought at the flowering stage obstructs pollination and considerably reduces yield. Towards harvesting dry conditions are necessary to support drying of the grain (Hughes, 1979; Schroeder *et al.*, 2013). As noted by Bergamaschi *et al.*, (2004) maize plants are sensitive to water deficit during a critical stage from flowering to the start of grain filling period. At this stage, there is high water requirement in terms of high evapotranspiration and high physiological sensitivity as number of ears per plant and number of kernels per ear is determined.

In Kenya small scale maize production accounts for 75 percent while large scale production account for 25 percent (Export processing Zone Authority, 2005; Olwande, 2012). Hybrid varieties correspond to different agro ecological zones. Highland maize varieties include H627, H626 and H625 while those recommended for medium altitude agro- ecozone include H513, H515, H516, H623 and H624. In the lowland agro-ecozone, Pwani hybrids PH1 and PH4 are recommended, they are short, resistant to lodging and more tolerant to moisture stress. As well, In the dry land agro-ecozone the varieties recommended varieties include Katumani Composite, DH01, DH02, DH03, DH04, and Makueni SCDUMA43 (Schroeder *et al.*,2013; Kenya Seed Company, 2013; National Farmers Information Service (NAFIS), 2015).

Enhancement of maize production is critical as a shortage in maize supply is, largely, synonymous with food insecurity (Owour, 2010; Republic of Kenya, 2000; 2005; 2010). Majority of households in Kenya grow maize, as it is the main staple food. It forms the diet of over 85 percent of the population, accounts for 68 percent of daily per capita cereal consumption, 35 percent of total dietary energy consumption and 32 percent of protein consumption (FAO, 2008a; Mohajan, 2014). Hence, Kenya's national food security has a strong relation to production of sufficient quantities of maize to meet an increasing domestic demand arising from a growing population. In addition, maize accounts for more than 20 percent of total agricultural production and 25 percent of agricultural employment (FAO, 2008a;Schroeder *et al.*, 2013; Mohajan, 2014).

In the face of the need to increase maize production, there is evidence of stagnation in maize production and productivity. This has led to an increasing gap between production and consumption besides increasing frequency of supply shortages. Figure 3 depicts maize yield trend in Kenya for the period 1970 to 2014.

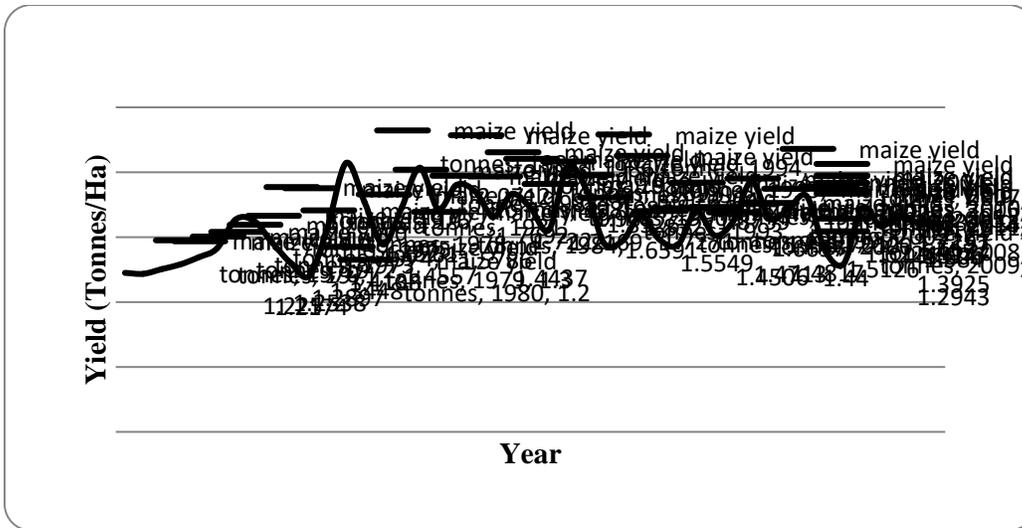


Figure 3. Maize Yield Trend in Kenya (1970-2014)

Source: Republic of Kenya. Economic Survey (Various Issues).

Figure 3 shows that there was tremendous growth in maize production between 1970 and 1982 with a peak yield of 2.07 metric tonnes per hectare. After 1982 there was a slight decline in yield after which the yield improved to a high of 1.87 metric tonnes per hectare in 1994. The growth was highly attributed to introduction of hybrid maize (Kibaara&Kavoi, 2011). However, from 1994 there has been a decline in yield with the lowest yield of 1.29 metric tonnes per hectare in 2009. Consequently leading to maize consumption deficit over the years. Figure 4 shows the gap between maize production and consumption in Kenya for the for the period 1970 to 2014

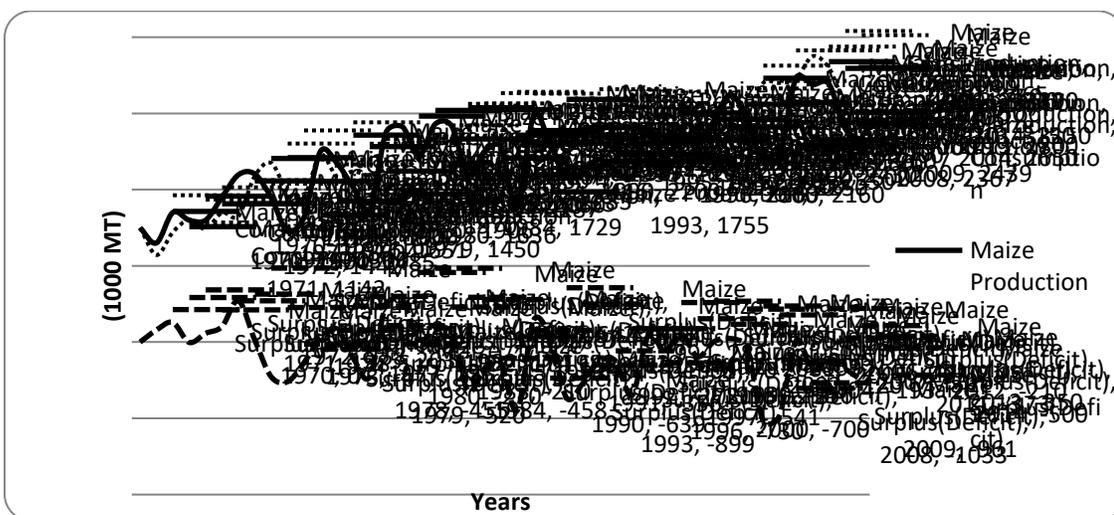


Figure 4. Maize Production and Consumption Trends in Kenya (1970-2014)

Source: Republic of Kenya. Economic survey (various issues).

Figure 4 demonstrates trends in maize production and consumption and the supply surpluses/ shortages. Notably maize production drastically dropped in some years such as 1979, 1984, 1993, 1997, 2008, 2013 and 2014. The trend shows wide fluctuation in maize production over the years resulting to a supply shortage since 1989 save for 1994, 2001 and 2003 where production was above consumption demands. Between 1970 and 2014, the average annual maize production stood at 2.3 million tonnes compared to an average annual consumption of 2.6 million tonnes in the same period (FAOSTAT, 2015). Equally, the production of rice and wheat, the main substitutes for maize, has been below the demand with the country only being able to produce 40 percent of its wheat requirements and 34 percent of the national rice consumption requirement (Republic of Kenya, 2003; 2005; 2009; 2011; 2015; Gitau *et al.*, 2011).

Moreover, growth rate in maize production has been marginal averaging about two percent which is lower than the annual population growth rate which averages 3.5 percent. Thus, for self sufficiency, maize production needs to grow by over 4 percent. Consequently, Kenya remains a net food importer with about 40 percent of its population being food insecure. As well, the overreliance on imports may trigger diversion of development resources for food procurement (Republic of Kenya, 2013; Mutimba *et al.*, 2010; FAOSTAT, 2015). The drop in maize yield coupled with increase in consumption compromises food security in the country.

#### **1.4 Problem Statement**

In Kenya, adequate supply of maize is an indication of food security, a source of employment and income generation. However, maize outputs levels have been fluctuating over the years making its production fall below consumption in most years. Further, the growth rate in maize output has been marginal, averaging about two percent which is lower than the annual population growth rate which averages 3.5 percent (Republic of Kenya, 2013; FAOSTAT, 2015). Consequently, there is need to have a

sustainable increase in maize output in order to continue supporting the livelihoods of the growing population in Kenya. However, sustainable maize production is likely to be affected by climate change.

Studies measuring the impact of climate change on crop yield in Kenya have concentrated on impacts of climate means (Jones & Thornton, 2003; Kabubo-Mariara & Karanja, 2007; Bilham, 2011; Cheserek, *et al.*, 2015). Beyond changes in climatic means, variability in temperature and rainfall is expected to rise in some regions, including the intensity and frequency of extreme events (Solomon *et al.*, 2007). Such changes are likely to have more adverse effects on crop yield than changes in climate means alone (Porter & Semenov, 2005; Tubiello *et al.*, 2007; Rowhani *et al.*, 2011). To bridge the gap, this study sought to empirically, determine the effects of climate change on maize yield, by incorporating climate variable means and their variability. Anchored on empirical analysis, detailed review of literature and by considering climate factors as direct inputs, the study examined the effect of rainfall and temperature and their variability on maize yield in Kenya.

## **2.0 Methodology**

### **2.1 Theoretical Model**

This study adopted a quantitative research design and employed production theory in developing theoretical framework and to specify empirical model. The study assumed that climate variables are likely to have nonlinear effects on crop yield. Thus, the study adopted a Cobb-Douglas production function from Blanc, (2011) and Mahmood *et al.*, (2012). Production theory explains the economic processes of producing outputs from various combinations of inputs. Moreover, production theory provides a convenient way of summarizing the production possibilities for the firm. The theory provides a way of determining the technologically feasible combination of output and various inputs. The common way of representing the relationship of output and input in physical terms is through the use of a production function. A production function describes a frontier that represents the maximum amount of output that can be obtained from a feasible

combination of various inputs (Varian, 1992; Nicholson & Snyder, 2008). In general a production function may be written as:

$$Y = f(A, K, L) \dots \dots \dots (1)$$

Where: Y is output; A is technology, K is capital and L is labor. One of the most commonly used functional forms of production function is the Constant Elasticity of Substitution (CES) production function. According to Arrow et al., (1961) a CES production function takes the form:

$$Y = A(\alpha K^\rho + \beta L^\rho)^{\frac{v}{\rho}} \dots \dots \dots (2)$$

Where: A is an efficiency parameter, equivalent to technology in (1);  $\rho$  is substitution parameter and it measures the ease with which two inputs can be substituted;  $\alpha$  and  $\beta$  are distribution parameters and they show how the two inputs are distributed over the production of one unit of output and v is the degree of the homogeneity of the production function and it's a measure of returns to scale. A CES production function assumes that the elasticity of substitution is constant. Under different assumptions about  $\rho$ , the CES production function can collapse into any of the specific forms. If  $\rho = \infty$  the two factors are assumed to be complements, with C.E.S manifesting itself as a fixed proportions/ Leontief production function. However, as  $\rho$  approaches zero CES will manifest itself as a Cobb Douglas function (Varian, 1992), which takes the form:

$$Y = AK^\alpha L^\beta \dots \dots \dots (3)$$

Hence, the two factors of production are imperfect substitutes. Augmenting or directly adding land and climate variables to equation (3) yields the most commonly used Cobb-Douglas production function in agricultural research. Climate variables are included to capture the effect of changing climate on agricultural output (Nastiset al., 2012). The augmented Cobb-Douglas is expressed as:

$$Y = AK^\alpha L^\beta Ln^\gamma W^\delta R^\theta \dots \dots \dots (4)$$



seeds used in kilograms per hectare.

Area under crop is included to capture decreasing marginal productivity, as farmers are assumed to cultivate in better soils first before expanding to land of lesser quality (Blanc, 2011). This study uses national data that reflect the actual cropping decisions and thus land is included as an explanatory variable to capture decreasing marginal productivity of land (Chen *et al*, 2004; Kawasaki & Herath, 2011; Blanc, 2011; De-Graft & Kweku, 2012). The coefficient of area under crop is expected to have a negative sign to indicate diminishing marginal productivity.

For given agronomic conditions, crop yield is expected to increase with increased consumption of fertilizers. However, excessive use can be detrimental as well (Winch, 2006). Although, use of fertilizer in Sub Saharan Africa is low there has been growth in use of chemical fertilizer in Kenya since 1990, thus this study incorporates fertilizer consumption as an explanatory variable for crop yield.

Labour is a key input in agricultural production in Kenya with most farmers especially the smallholder employing traditional farming methods where most land is cultivated manually. However, most of labor is provided by family members with the level of labor input depending on family structures and the number of hours worked. As well, labor requirements differ with season and labour characteristics such as education and health. In addition, farming experiences influence crop yield through work capacity and quality of crop management practices (Blanc, 2011). Labour data specifically used in production of specific crops under study in Kenya is limited and the rural population data available may not be a good proxy for labour used in production of each crop under study. The study thus adopted employment in agricultural sector in Kenya to capture use of labor in crop production process.

The vector of climate includes the level of precipitation and temperature. These variables are expected to have both direct and indirect effects on crop yields, especially under rain fed agriculture. Thus, in this study seasonal mean temperature and seasonal rainfall are included in the specification. As well, to capture the effect of climate risks emanating

from change in climate on crop yield, rainfall and temperature variability are included in the specification. Further, to account for nonlinear weather effects on crop yield, quadratic terms for rainfall and temperature are included in the specification.

### **2.3 Data Type and Source**

The study used annual time series data for the period between 1970 and 2014. The data was gathered from government publications, Kenya Meteorological Department, World Bank, IMF and FAOSTAT database. Weather variables used in maize model were computed using data from the following weather stations: Kitale, Nyahururu, Nyeri, Thika, Narok, Nakuru, Kabete, Machakos, Kakamega, Meru, Embu, Kisii, Kericho and Eldoret

### **2.4 Estimation Method and Unit root tests**

Crop yield model was estimated by Ordinary Least Squares (OLS) method. Prior to model estimation, series were subjected to various tests to confirm various properties required for OLS to give results that are efficient and consistent. The model was estimated consistently by OLS after ascertaining that the error term ( $\varepsilon_j$ ) is a white noise process or more generally, if the error term has a zero mean, constant variance and uncorrelated with the explanatory variables and its previous realizations. As well, given the use of time series data, it was necessary that, before estimation of the equations, the series had to be tested for unit root. The study employed the Augmented Dickey-Fuller (ADF), Philip Peron (PP) and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) tests. (Green, 2008; Gujarati, 2004; Dickey and Fuller, 1979; Kwiatkowski, Schmidt & Shin 1992).

The unit test results showed that variables are a mixture of I (0) and I (1), the models could not be estimated at levels, since there is a likelihood of yielding spurious results (Heijet *al.*, 2004; Woodridge, 2012). An alternative is to use the first difference of variables. Although, using the first difference changes the nature of model, the method is as informative as modeling in levels (Woodridge, 2012). Thus maize yield model was estimated at first difference. To ensure that estimates obtained were unbiased and

consistent, diagnostic tests were undertaken. The tests included: the normality test using Jarque- Bera statistics, Breuch-Godfrey Lagrange Multiplier test for serial autocorrelation, Lagrange Multiplier test for autoregressive conditional heteroskedasticity (ARCH), Ramsey RESET test for specification error and CUSUM test for parameter constancy. The P values associated with the computed test statistics were greater than 0.05 and thus the estimates were considered to be unbiased and consistent.

### **. 3.0 Empirical Results and Discussion**

### 3.1 Effects of Rainfall and Temperature on Maize yield

The coefficient estimates for the crop's yield model are shown in Table 1.

**Table 1: Maize Yield Model Coefficient Estimates**

Dependent Variable		D(Maize Yield)	
Explanatory variables	Coefficient (Standard Errors)	Explanatory variables	Coefficient (Standard Errors)
D(Area Under Crop)	-6.35E-07*** (1.84E-07)	D(Squared Rainfall- MAM)	-8.46E-06*** (1.62E-06)
D(Mean Temp-JF)	-0.1222 (0.0905)	D(Squared Rainfall- OND)	-2.16E-06 * (1.07E-06)
D(Mean Temp- JJAS)	13.35869*** (3.7886)	D(Squared Mean Temp- JJAS)	-0.375089*** (0.1059)
D(Mean Temp-MAM)	10.66330*** (3.5293)	D(Squared Mean Temp- MAM)	-0.272724*** (0.1842)
D(Mean Temp-OND)	0.09483 (0.1151)	D(Fertilizer use)	0.01916** (0.0071)
D(Rainfall-JF)	-0.002596*** (0.0009)	D(Labor use)	-8.413114 (8.5114)
D(Rainfall-JJAS)	0.002399 (0.0025)	Constant	-0.002621 (0.02118)
D(Rainfall-MAM)	0.008577*** (0.0085)	R-squared	0.88
D(Rainfall-OND)	0.001972** (0.0008)	Adjusted R-squared	0.75
D(Rainfall Variability)	-0.099747 (0.3028)	F-statistic	6.63
D(Temperature Variability)	-0.05939** (0.0303)	Prob(F-statistic)	0.00

D(Squared Rainfall-JF)	7.13E-06*** (2.32E-06)	Durbin-Watson stat	1.80
D(Squared Rainfall-JJAS)	-1.84E-06 (4.04E-06)		

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Standard errors in brackets; \*\*\*, \*\*, \* significant at 1%, 5% and 10% respectively

Source: Author's computation.

The regression model yield a relatively moderate value for adjusted R squared. The adjusted R<sup>2</sup> values of 0.75 implies that 75 percent of variations in maize yield are explained by climate variables, area under crop, fertilizer consumption and labour use.

### 3.2 Marginal Effects of Rainfall Amount on Maize yield

The study findings indicate a nonlinear relationship between maize yield and rainfall. Specifically, the coefficients estimates of linear terms of rainfall in March to May period and October to December period are positive and significant at 1 percent and 5 percent level respectively. Conversely, the coefficient estimate of linear term of rainfall in January to February period has a negative sign and is significant at 1 percent level. However, the coefficient of linear term of rainfall in the June to September period and the coefficient of rainfall variability are insignificant. The coefficients of squared rainfall amount in the period of March to May and October to December have a negative sign and are significant at 1 percent and 5 percent level respectively. This implies that, during the long rains and short rains period, an increase in rainfall raises maize yield with diminishing marginal benefits up to a maximum turning point after which further increase in rainfall, impacts maize yield negatively.

Since both level and square of rainfall variables are in the model, the marginal effects need to be calculated. The marginal impact of rainfall in January to February period is specified as:

$$\frac{\partial \Delta Q}{\partial \Delta R_{JF}} = -0.002596 + 2(7.13E - 06)\overline{\Delta R_{JF}} \dots \dots \dots (6)$$

Holding other variables constant, an increase in rainfall amount by 1 mm relative to the periods mean rainfall amount of 117.6 mm decreases maize yield by 0.0009 tonnes per hectare.

The marginal impact of rainfall in March to May period is specified as:

$$\frac{\partial \Delta Q}{\partial \Delta R_{MAM}} = 0.008577 - 2(8.46E - 06)\overline{\Delta R_{MAM}} \dots \dots \dots (7)$$

Holding other variables constant, an increase in rainfall amount by 1 mm relative to the periods mean rainfall amount 465.33 mm increases maize yield by 0.0007 tonnes per hectare.

During the October to December period the marginal effect of rainfall on maize yield is given as,

$$\frac{\partial \Delta Q}{\partial \Delta R_{OND}} = 0.001972 - 2(2.16E - 06)\overline{\Delta R_{MAM}} \dots \dots \dots (8)$$

Holding other variables constant, an increase in rainfall amount by 1 mm relative to the periods mean rainfall amount 334.66 mm increases maize yield by 0.0005 tonnes per hectare.

The results indicate that an increase in rainfall, prior to the main planting period has a negative effect on maize yield. January to February period lies outside the growing season but usually corresponds to a stage where the short rains crop grown in medium potential -areas that support two growing seasons- is harvested and drying conditions are necessary. As noted by Hughes (1979) and Schroeder et al., (2013), towards harvesting, maize requires dry conditions towards to support drying of the grain. In addition, dry conditions during January to February period, facilitates adequate land preparation before planting at the onset of long rains in March. This indicates that dry conditions in January to February period, provide an enabling environment for drying of grain and adequate

time for land preparation, which enhances yield. Thus, early rains can distort farmers planting plans, as they have a short time to prepare their land and as well, they may not have adequate resources in January to purchase farm inputs, thereby adversely affecting yield. This finding is consistent with Cabas (2009), who observed that an increase in precipitation in months around planting and harvesting decreases crop yield. Conversely, Kawuna (2011) indicated that in Ethiopia Pre-season rainfall had a positive effect on maize production.

Increase in rainfall during the growing period for the main crop as well as the short rains crop is expected to increase maize yield but at a decreasing rate. As maize crop goes through the vegetative and reproductive stages, sufficient rainfall water is required. However, water level beyond the crop requirement has a negative effect on yield. These results are consistent with the findings made by Akpalu *et al.*, (2008), Blanc (2011) and Bhandari, (2013) that precipitation has a positive effect on maize yield while Sowunmi and Akimola (2010) concluded that with sufficient water maize can be grown in many parts in Nigeria. The nonlinear influence of rainfall on maize yield is consistent with the finding made by Cabas, (2009) and Blanc (2011). Further, Moula (2008) and Bhandari, (2013) observed that rainfall variability has a negative effect on maize yield. Conversely, Rowhaniet *al.*, (2011) estimated that an increase in inter seasonal precipitation reduces maize yield.

### **3.3 Marginal Effects of Temperature on Maize yield**

On the effects of temperature on maize yield, estimates from the maize yield model as shown in Table 4.4, show that the coefficients of linear term of mean temperature in the march to May period and June to September are positive and significant at 1 percent level. The coefficient of temperature variability is negative and weakly significant at 10 percent level. However, the coefficients of linear terms for mean temperature in January to February and October to December periods are insignificant.

The coefficients of squared term of mean temperature in the March to May period and June to September period are negative and significant at 1 percent level, indicating an

inverted U relationship. This result indicate that during the main crop growing season an increase in temperature is of benefit to crops but does so with diminishing marginal benefits up to some optimal point beyond which an increase in temperature would have damaging effects.

The marginal effect of temperature in March to May period is specified as.

$$\frac{\partial \Delta Q}{\partial \Delta T_{MAM}} = 1066330 - 2(0.272724)\overline{\Delta T_{MAM}} \dots \dots \dots (9)$$

Holding other variables constant, a rise in temperature by 1<sup>0</sup>C mm relative to the period's average of 19.9<sup>0</sup>C reduces maize yield by 0.19 tonnes per hectare.

The marginal effect of temperature in June to September period is specified as.

$$\frac{\partial \Delta Q}{\partial \Delta T_{JJAS}} = 13.35869 - 2(0.375089)\overline{\Delta T_{JJAS}} \dots \dots \dots (10)$$

Holding other variables constant, a rise in temperature by 1<sup>0</sup>C mm relative to the period's average of 18.25<sup>0</sup>C reduces maize yield by 0.33 tonnes per hectare.

The coefficient of temperature variability is negative and weakly significant at 10 percent level. The coefficient estimate indicates that when temperature variability increases by one standard deviation, maize yield decreases by 0.06 tonnes per hectare. The nonlinear relationship between temperature and maize yield observed in the main crop growing season shows that increase in temperature leads to an increased yield but beyond the optimum level, further increase in temperature reduces maize yield. This can be as a result of the fact that higher temperatures when water /moisture is limiting usually dry out silks and damage pollen resulting in scatter grained ear or an ear with a barren tip. Consequently, this causes maize yield and output supply to decline (FAO, 2015; Wiatrack, 2015).

These results are consistent with the findings made by Rowhaniet *al.*, (2011), Blanc (2011) and Ereghaet *al.*, (2014)that temperature has a negative effect on maize yield. Similarly, the results are consistent with those of Cabas (2009) that increase in

temperature can have both positive and negative effect depending on the season. On the contrary, Akpalu *et al.*, (2008) and Bhandari, (2013) found that maize yield responds positively to temperature. The finding that temperature variability has influence on maize yield is consistent with the finding made by Moula (2008), Cabas (2009) and Bhandari, (2013). As well, the study findings are consistent with other studies that found a nonlinear relationship between temperature and precipitation on crop production (Mendelsohn *et al.*, 1994; Kabubo-Mariara and Karanja, 2008; Krukulasuriya and Mendelsohn, 2008; Cabas *et al.*, 2009; Rowhani *et al.*, 2011).

The findings indicate that during the growing season for maize, there is a higher yield, when rainfall is sufficient and when temperature is not beyond the required optimum. Adequate moisture content, during the growing period, which corresponds to March to May period and June to September period for the main crop varieties and October to December for the short rain varieties, boosts availability and uptake of nutrients. This makes the plants stronger and less susceptible to disease and insect damage ultimately increasing maize yield.

### **3.4 Marginal Effects of Economic Variables on Maize yield**

Coefficients estimate for area under crop indicate that changes in area under crop has significant effect on maize yield. The estimated coefficient has a negative sign and is significant at 5 percent level. This result indicates that owing to decreasing marginal land productivity, maize yields is decreasing, as area under crop increases. The coefficients of fertilizer consumption is positive and significant at 5 percent level of significance. As fertilizer consumption increases by one kilogram, maize yield increases by approximately 0.0192 tonnes per hectare. Use of fertilizer improves soil fertility and is useful in replenishing soil nutrients. Thus, use of fertilizers for sustained crop yield is integral given that in Kenya, farmers cultivate sub optimal land and use the same plot season after season given that only 20 percent of land in Kenya is agriculturally productive (Johnson *et al.*, 2003; Sheahan, 2011). The coefficients of labor use is insignificant while the coefficient of maize seed use is positive and significant at 5 percent level. The results show that an increase in the use of certified seeds by 1 kilogram raises maize yield by

0.046 tonnes per hectare. This indicates that one of the ways to increase maize productivity is to increase the use of certified maize seeds, as noted by Okoboi et al., (2012) farmers who apply fertilizers on improved seeds record the highest maize yield. Thus, limited use of fertilizers and improved seeds is one of the major constraints in raising maize yield.

### **3.5 Conclusion and policy implications**

Maize yield analysis provides an insight on how climate change influences crop yield. The analysis showed a concave relationship between maize yield and rainfall in the long rains and short rains period. These indicate that an increase in rainfall is expected to raise yield but with diminishing marginal benefits. The findings indicate that water remains an integral factor in maize production and occurrence of adequate rainfall is imperative in boosting maize yield. Thus, low and unreliable rainfall restricts suitability of maize production and has been a contributor to declining maize yield in Kenya. Early rains have a negative effect on maize yield and indicator that changes in rainfall patterns could be making it hard for farmers to make proper and timely decisions. The unpredictability of Kenya's rainfall and its trend to fall heavily in a short period is likely to raise the climate risk faced by small scale farmers consequently raising uncertainty to food security.

The effects of increase in temperature on maize yield depend on the season and to an extent the stage of crop growth and development. Overall, the study finds that increase in temperature has a negative effect on maize yield. A concave relationship between maize yield and mean temperature is observed in March to May season. Thus, increase in temperatures beyond the optimum level even in wet seasons lowers maize yield. Additionally, analysis show that larger effects of change in temperature and rainfall on maize production are observed in the main crop growing period. These results indicate that warmer temperatures when water is not limiting tend to benefit maize crop up to a maximum threshold beyond which further increase becomes detrimental. Hence, with a projected rise in temperature maize production is likely to reduce, hence there is need to establish measures geared towards averting the situation.

Evidently, from the study findings climate variability has an adverse effect on crop production in Kenya, posing a greater concern food security. Thus, there is need for a wide-ranging policy that will elevate the potential of rain fed agriculture in the midst of the risks posed by climate change. The significant response of maize yield to climate variability points to a possible decline in crop production in the future, in absence of adaptation and mitigation mechanisms. In turn, this would make Kenya more food insecure and adversely affect foreign revenue, employment and income generation.

The adverse effects of climate change on maize yield creates a need to formulate all-inclusive policies, strategies, and instruments that specifically address effects of climate change, paramount in building adaptation and mitigation mechanisms. Specifically, amid the threat to food security, there is need to: shield highly productive agricultural land from other non-agricultural developments especially real estate development; Provide climate information to relevant stakeholders in a timely and useful format and supplement rainfed agriculture through irrigation which can be attained through rainwater harvesting. This calls for Ministry of Agriculture, Kenya Meteorological department and relevant stakeholders to commit more resources towards adaptation and mitigation mechanisms.

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## Effect of Weeds in Yield Loss of Beans

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### ABSTRACT

Weeds are unwanted plants growing in agricultural lands, gardens, road sides and mainly disturbed areas where they do not depend on human intervention for their reproduction and survival. Depending upon density, types, duration of competition, management practices and weather conditions, weeds may cause a reduction in crop yield. To determine the effect of weeds on the yield of beans, an experiment was carried out in University of Eldoret research farm in 2017 for two seasons. The area is located in Uasin Gishu county, Kenya and lies at an altitude of 2133 m above sea level. Geographically, the area is at 35° 18' E longitude and 0° 30'N latitude. The experiment was laid out as a factorial in Randomized Complete Block Design (RCBD) with three bean varieties and three treatments. The treatments were weed free plots, weedy plot and plots with single weeding. The data obtained were subjected to ANOVA using Genstat version 14 and means separated by Duncan's Multiple Range Test (DMRT). Results indicated that weeds significantly reduced the yield of all the three bean varieties from between 12-27%. From the results, it was deduced that all the bean varieties tested were susceptible to yield loss due to weeds. The study recommends for proper weed control in beans so as to realize good yields.

**Keywords:** weeds, competition, yield loss, varieties, management, duration.

### INTRODUCTION

Weeds are one of the most serious problems in agricultural production. They are volunteer plants from the wild or semi culture crops that are found in food crops despite the will of the people and harm reducing yields (). According to a FAO 2008 report, from the total losses worldwide caused by the crop pests, weeds account for 35% of losses in wheat, 28% in vegetables, 29% in fruits and 37% in tobacco (Slaveya et al., 2015). Since losses due to weeds are not as pronounced as those due to insect pests and diseases, the idea of weed control has been ignored for long.

In spite of a multitude of control options, weeds still cause major losses in crop production. Documenting yield losses caused by weed infestation would supply a useful knowledge base which could be used to direct research goals in the area of weed management by identifying areas of greatest need (Oudhia, 2001). Weeds, through allelopathy have been found responsible for perturbation of emergence and stand

establishment, growth, yield and physiology of crop plants.

Common beans (*Phaseolus vulgaris* L.) is the most widely grown legume in Kenya, with average per capita consumption of common bean in Africa estimated at 31.4kg/year (Schoonhoven and Voysest, 2011). Common Cultivars include; Rose coco , Canadian wonder, Kenya wonder, Zebra, *Mwitmania*, *Mwezi moja*, *mwezi mbili*, Red haricot, Nyayo, Wairimu Dwarf.

Productivity of common beans is constrained by many factors among them weeds which compete for nutrients, space and sun light. In view of the losses caused by weeds, this paper therefore makes an attempt to elucidate the effects of weeds to crop plants on areas of stand establishment, crop growth and yield parameters.

## **MATERIALS AND METHODS**

### **Site description**

The experiment was carried out in University of Eldoret farm, Uasin Gishu county which lies at an altitude of 2133 m above sea level. Temperatures range between 9.5<sup>0</sup> and 23.5<sup>0</sup>C. Rainfall is bimodial and averages at 885 mm p.a. The soils are well drained, reddish brown ferrasols.

### **Test crop**

The test crop was common bean of three varieties commonly grown: Rosecoco, *Mwitmania* and *Mwezi mbili*.

### **Treatments**

In the present study, two weed control methods together with a control were studied. Three bean varieties were grown in two cropping seasons.

### **Experimental design and treatments**

The experiment was a 3x3 factorial arranged in a Randomized Complete Block Design (RCBD) with three replicates. This gives a total of 27 plots.

The field arrangement is as shown below:

W1V1	W3V3	W2V2	W2V1	W1V2	W2V3	W3V1	W2V2	W3V3
W3V1	W1V2	W2V3	W1V3	W3V1	W2V2	W1V2	W3V2	W1V3

W3V2	W1V3	W2V1	W3V2	W3V3	W1V1	W2V1	W2V3	W1V1
<b>Block 1</b>			<b>Block 2</b>		<b>Block 3</b>			

### Agronomic practices

All the required agronomic practices were applied as required.

### Data collection

In order to meet the objectives of the experiment, data were collected on the following parameters:

#### a) Stand count at two weeks

The total number of bean plants in an experimental unit was counted and recorded two weeks after germination.

#### b) Stand count at harvesting

This is the total number of bean plants at the time of harvested. It was obtained by physically counting the stems per plot.

#### c) Number of seeds per pod

The number of seeds per pod was obtained after harvesting. Bean pods of selected plants were opened up and the number of seeds counted.

#### d) Number of pods per plant

This was obtained by physically counting the number of pods in randomly selected plants. An average was obtained per plot.

## RESULTS

The table below shows the results of the experiment:

Parameter	Treatment	Season 1			Season 2		
		V1	V2	V3	V1	V2	V3
		Mean			Mean		
<b>Stand count at 2 weeks</b>	Weedy	45.67	44.00	44.33	33.33	33.33	31.67
	Weed free	44.67a			32.78a		
	Single weeding	45.33	45.67	45.33	44.00	44.67	43.00

		45.44a				43.89c			
		44.33	44.67	45.00		39.67	39.00	40.00	
		44.67a				39.56b			
	DMRT 0.05			0.65				0.16	
	Mean	45.11a	44.78a	44.89a		39.00a	39.00a	38.22a	
	DMRT 0.05	0.38				0.67			
	CV (%)	2.5				5.2			
<b>Number pods per plant</b>	Weedy	3.33	3.67	4.67		1.67	2.33	2.00	
	Weed free	3.89a				2.00a			
	Single weeding	12.67	15.33	18.67		14.67	17.00	17.67	
		15.56c				16.44b			
		8.00	14.33	11.67		8.00	14.33	11.67	
		11.33b				11.33c			
	DMRT 0.05			1.08				0.97	
	Mean	8.00a	11.11b	11.67b		8.11a	11.22b	10.44b	
DMRT 0.05	0.62				0.56				
CV (%)	18.2				16.9				
<b>Number of seeds per pod</b>	Weedy	1.33	2.00	1.67	1.67a	1.00	1.00	1.67	1.22a
	Weed free	6.33	7.33	10.67	8.11c	7.00	7.33	10.00	8.11c
	Single weeding	4.33	5.33	6.33	5.33b	5.67	5.67	5.67	5.67b
	DMRT 0.05			0.48					
	Mean	4.00a	4.89b	6.22c		4.56a	4.67a	5.78b	
	DMRT 0.05	0.27				0.25			
	CV (%)	16.3				14.7			
<b>Stand count at harvesting</b>	Weedy	12.33	16.33	22.00		10.33	13.33	15.67	13.11a
	Weed free	16.89a				44.00	43.67	45.00	
	Single weeding	44.00	43.67	45.00		44.22b			
		44.22c				36.00	39.33	40.00	38.44c
		36.00	39.33	40.00					

		38.44 <b>b</b>	
	DMRT 0.05	1.61	1.70
	Mean	30.78 <b>a</b> 33.11 <b>ab</b> 35.67 <b>b</b>	30.11 <b>a</b> 32.11 <b>ab</b> 33.56 <b>b</b>
	DMRT 0.05	0.93	0.98
	CV (%)	8.4	9.2

## DISCUSSION

### **Effect of treatment on stand count at two weeks and at harvesting**

From the analyzed results, treatment and variety of the beans did not significantly influence the stand count of beans at two weeks in season 1. In season 2, weedy plots had significantly lower stand counts at two weeks. The results can be attributed to the effect of the weeds affecting germination of crops through allelopathy. According to Kholi *et al.*, 2004, allelochemicals produced by plants act through interference with physiological functions of receiver plants such as seed germination, root growth, shoot growth and stem growth.

In addition to allelopathy, stand count at harvesting was affected by competition thereby weak bean plants were outcompeted in weedy plots.

### **Effect of treatment and variety on bean yield parameters (number of pods per plant and number of seeds per pod)**

The results shown above demonstrate that the variety used had significant effects on the number of pods per plant and the number of seeds per pod, which are important determinants of yield. Variety 2 (Mwitmania) and Variety 3 (Mwezi mbili) have a natural ability to grow tendrils. This is an advantage to them in weedy environments where the tendrils twine on strong weeds and are able to access the sun for photosynthesis. Due to this, the varieties performed better at a mean of 11 and 12 pods per plant and 5 and 6 seeds per pod respectively.

On treatment, there were significant differences in all the treatments applied on the parameters in question. This can be attributed to competition and allelopathy. In weedy plots, competition for nutrients, space, light and pollinators was high and the plants set

aside much of their resources in countering the impact of competition rather than to production. Allelopathic effects of weeds were also noted whereby there was plant death around some specific weeds.

The impact of allelochemicals on plant photosynthesis mainly involve inhibition of or damage to the synthesis machinery and acceleration of the decomposition of photosynthetic pigments (Rao *et al.*, 2007). Consequently, photosynthetic pigment contents are decreased, which blocks energy and electron transfer, reduces ATP synthesis enzyme activity, inhibits ATP synthesis and affects stomatal conductance and transpiration, which inhibit photosynthesis (Wu *et al.*, 2004). All these lead to decreased crop yields.

### **CONCLUSION AND RECOMMENDATIONS**

This study concluded that crop yield can be reduced due to weed interference. Emphasis is placed on the importance of weed management in bean production and the need for continued weed science research to develop long-term, sustainable, integrated weed-management systems that are tailored to the various crop-producing regions.

There is need for continuous up-to-date research on weed control in beans that can ensure higher yields for the farmers and hence food security.

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## Screening Selected Maize single crosses for tolerance to Low P in Acidic soils of Bumala and Maseno

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### ABSTRACT

Generally, 13% of Kenya's arable land mass (7.5 million ha) is acidic and prone to poor phosphorus (P) availability and soil acidity. This results in crop yield losses due to the direct adverse effects Aluminium toxicity and P deficiency due to fixation of this element in the soil. The objective of this study was to develop and select P efficient maize single crosses developed by crossing as per North Carolina II mating design. Sixty maize genotypes, among them 34 single crosses were screened under acidic soils in Bumala and Maseno in a randomised complete block design. Sixty-seven percent of these single crosses were efficient, while 33% were inefficient. Two percent were efficient and responsive, 14% were inefficient but responsive, and the 79% were efficient but non-responsive. Generally, GY had a positive correlation with EH (0.45) and PH (0.61), while PH and EH had a positive correlation ( $r=0.86$ ) for the single crosses. The addition of P had significant effect on the grain yield, plant height, ear height and flowering of the genotypes at Bumala and Maseno. However the effect of 26kgP/ha was marginal at Maseno as compared to Bumala. The sites and genotypes varied significantly with regard to soil analysis and grain yield respectively, with the efficient and responsive genotypes selected for use in low input farming systems. Also, some of the efficient but non-responsive lines can also be selected for low input farming.

**Keywords:** Maize, Single crosses, Aluminium toxicity, P efficiency,

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### INTRODUCTION

Globally, maize is considered as the third in importance after wheat and rice among consumed cereals (Ali et al., 2013; Onasanya, 2009). In Sub Saharan Africa and Kenya, the cereal is ascribed a unique importance because of its value as a staple food crop, an industrial raw material and an animal feed (Magenya et al., 2008). Produced by both small and large scale farmers, maize provides Kenyans with a source for approximately 35.7% of consumed calories (Gichuru, 2013) due to its staple status. However, its production is hampered by both biotic and abiotic constraints (pests, diseases, poor

weather and soil conditions, poor seed quality, etc.). Soils that are categorised as being low in available P are however considered major challenge to maize productivity (Ouma et al., 2015). Also according to Mageny et al (2008) and Gichuru (2013), P sorption in acid soils that leads to P deficiency, poor soil fertility, significantly lowers maize productivity. In Kenya, approximately 7.5 million ha of maize producing as well as agriculturally viable land is acidic (Kisinyo et al., 2014). In such soils, applied P becomes fixed due to acidity and concurrent aluminium toxicity (Mumtaz et al., 2014), thus making chemical amelioration less effective. In western Kenya, soil acidity is a common occurrence and is commonly associated with aluminium toxicity as well as P deficiency. Such areas are reported as expressing an available soil P of between 2-5 mg/kg, whereas the minimum threshold for maize production is set at 10mg/kg (Brink and Bellay, 2006; Yang et al., 2013; Kisinyo et al., 2014; Ouma et al., 2012). This situation has resulted in yield losses of between 20%-58%, while its accompanying Al toxicity has resulted in yield losses of between 16%-45% (Kisinyo et al, 2011; Ouma et al.,2012). Addressing the issue of low P availability therefore becomes vital in Western Kenya.

Phosphorus is among the major crop nutrients required for growth and development of crops, and deficiencies of this mineral leads to negative effects on the crop's development process and eventually reducing yield (Ward et al., 2011). As a major nutrient, this element is required in significantly larger amounts, similar to Nitrogen and Potassium. It is an important molecule in the ATP molecular structure as well as in phospholipids and nucleic acids and is an essential requirement in photosynthesis (Obura et al., 2009). In addition to these roles, Phosphorus availability is important in minimizing Aluminium induced root damage, and ameliorating accumulation of the toxin in root tips cells (Sun et al.,2008). In terms of importance, the fully oxidised and inorganic form of this mineral element is considered as the most important form for plant use due to its function in the above mentioned roles (Satyaprakash et al., 2017). In addition to soil acidity and Al toxicity, P availability is also influenced by lack of or presence of organic matter in soil as well as the continual use of acidic fertilisers (Sharma et al.,2013; Ware, 2006). Crops exposed to low P conditions express symptoms such as the progressive purpling of leaves from tips to the margins and eventually the whole leaf, necrosis of the stem, poor flowering and seed fill, poor yields, and the complete elimination of young susceptible

plants (Fageria, 2009).

Traditionally, P deficiency can be ameliorated by application of lime or organic and inorganic fertiliser's (Kisinyo, 2011). However, in most P deficient soils, only 20% of applied P remains available for plant use and acquisition in a majority of soil ecosystems due to fixation of the remaining 80% (Balemi & Ngeshio 2012; Mumtaz et al., 2008). This then, due to the diverse nature of soil, leads to the development of P depleted pockets supplying between 10-15% of supplied P (Obura et al., 2014), and a process that may eventually lack economic sustainability. In addition, liming or the use of other soil amendments, is considerably expensive for small scale farmers (Kisinyo et al., 2014; Ouma et al., 2012), and it is therefore prudent to explore genetically conditioned tolerance. According to Kisinyo et al(2014), maize genotypes with adequate phosphorus utilization potential (PUE), or those adopted to enhanced acquisition of P (PAE) become an indispensable tool in dealing with the constrain of low available P especially for low income small scale farmers. This study therefore aimed at selecting P efficient F1s from an F1 group developed by crossing.

## **MATERIALS**

### (i) Study Sites

The study was carried out in three different locations, Rongo University, Maseno University and Bumala. Rongo University farm was the crossing site for development of single cross hybrids, Maseno university farm and the farmer's field in Bumala were the sites for evaluation of the F1 hybrids. Rongo University is located at between 1300-1500m a.s.l, receives an average of 1600mm of rainfall pa, and experiences a temperature of between 20-21.7°C (Low, 1997; MoA, 2014). Bumala is located between 1135-1500m a.s.l, experiences a temperature of between 20.5-22.7°C, receives an annual rainfall of approximately 900-1700mm, and is reported as having acidic soil with ah pH of 4.5-4.6 and available soil P of 2.74 mg/kg (Ouma et al.,2012). Maseno is located approximately 1500m a.s.l, experiencing a rainfall average of 1750mm pa, a temperature of 28.7°C, and is has acidic soil of pH 4.5-5.4 with an available soil P of 4.5 mg/kg (Gichimu et al.,2009). While soil s in Bumala are classified as orthic ferralsols (Ouma et al., 2012), Maseno soils are classified as dystric nitisols (Mwai et al., 2001).

(ii) Genetic material

The germplasm used in the study was sourced from Rongo University and the University of Kwazulu Natal. From Rongo university was sourced the 14 Aluminium tolerant and P efficient maize genotypes, while the 9 Maize streak virus tolerant genotypes were sourced from the University of Kwazulu Natal. The material from the University of Kwazulu Natal were all inbred lines, while from Rongo University were a mixture of inbred lines, and populations from Brazilian introductions (Ouma et al., 2012).

## **METHODOLOGY**

(i) Development of Single Cross hybrids

Crossing was done in Rongo, at the University collage field in the short rains of 2015, using the North Carolina II mating design with the Kenyan inbreds as female and South African inbreds as male. Pollen was transferred in pollen bags set up overnight from the tassel of the male plants to the silks of the female plants at 9 am in the morning to 10 am during the two week flowering period. It resulted in 34 single cross genotypes for screening. The crossing block consisted of two plots staggered by a week and a half, each consisting of two plots (male and female), with each male and female having two rows for each of the genotypes.

(ii) Field screening for tolerance to Maize streak virus, Aluminium toxic/ P efficient

The field experiment was laid out in RCBD with the genotypes and two P levels, P0 and P1, as treatments. Each treatment was replicated twice. A total of 34 single crosses, 2 repeats, 23 parietals and 1 check were evaluated. Each plot had ten genotypes and each block has six plots, with each genotype represented in singular rows (3m long, with 0.75 m inter-row spacing and 0.25 m intra-row spacing) (Gichuru, 2013; Ngwira & Khonje, 2005; Scott *et al.*, 2009).

The genotypes under screening were subjected to two rates of P, (P0) 0kgP/ha and (P1) 26Kg P/ha) while N was applied at 30kg N/ha at planting and at knee height 45Kg N/ha (NAFIS; Gudu *et al.*, 2011; Gudu *et al.*, 2005). Due to its capacity to supply N at 18%, which is equivalent to 6.48 kg of N per 100kg DAP, the treatment with -P (P0) was supplied slightly more CAN than +P (26kgP/ha) to balance the 18% N supplied by DAP.

### (iii) P-deficiency tolerance assessment

P efficiency was evaluated on basis of grain yield (GY), plant height (PH), ear height (EH), days to 50% silking and 50% anthesis. Data was collected for all these traits for P efficiency assessment (Jiang *et al*, 2010; Too *et al*, 2014), with plant height and ear height being collected at plant maturity.

Model:  $Y_{ijk} = \mu + b_i + P_j + G_k + PG_{jk} + \epsilon_{ijk}$

Where;  $\mu$ -general mean, b- blocking effect, G- Genotype effect, P- Treatment effect, PG-treatment genotype interaction,  $\epsilon$ -error term

% Response to P application of P for the various inbred lines and single cross hybrids was calculated according to Ouma et al (2012) as:

$$\%R = \frac{P1}{P0}$$

### (iv) Data analysis

The data for analysis was subjected to ANOVA in GENSTAT version 14 and mean separation done using DMRT test at 5% level of significance.

### (v) Soil Sampling

Soil sampling was done using systemic quadrates (Midwest Laboratories, 2004; Okalebo et al., 2002), and the zigzag method (Okalebo et al., 2002). The method used nested the zigzag systems within the quadrates. The sub-samples were mixed thoroughly and approximately 1.2 kg composite samples were packed in a black polythene bags and transported to the laboratory for were air-drying, grinding and sieving via a 2 mm sieve. The samples were then tested for pH using the HANNA soil analysis tool kit (Vanek, 2017), texture and organic carbon according to Okalebo et al (2002), and available P using Olsen et al (1954).

## **RESULTS**

### (i) Soil testing results

Results of the soil analysis showed that the two sites were generally low in fertility, and also had low pH and available P. Bumala had a pH 4.6, while Maseno had a pH was 5.2.

These values indicated that the two sites have strongly acidic soils (Table 1), with Maseno having a slightly higher available P. The two sites also had low C level but Maseno had a slight advantage over Bumala for this trait as well.

Table 1: Soil analysis results for the experimental plots used in the study at Maseno and Bumala.

SITE	Organic Carbon	P	pH	Textural Class	Soil Type
BUMALA	2.66	3.3	4.6	Sandy clay loam	Orthic ferasols
MASENO	3.18	4.8	5.2	Clay loam	Dystric Nitrisols

(ii) Response in P deficient/ low P conditions in Acidic soils of Maseno and Bumala

The genotypes used in the study varied significantly in terms of PH, EH, GY, days to 50% silking and days to 50% tasseling ( $p < 0.05$ ), with the single cross hybrids outperforming the parental inbred lines under both low P (0kgP/ha) and high P (26kgP/ha) conditions. The interaction between the genotypes and sites was significant ( $p < 0.05$ ) for GY, PH, EH, days to 50% tasselling and days to 50% silking. The interaction between sites and P was significant ( $p < 0.05$ ) for GY, PH, EH, and days to 50% tasselling but not for days to 50% silking, while the interaction between genotypes and P was significant ( $p < 0.05$ ) for GY, PH, EH. Only PH and EH were significantly affected by the interaction between site, genotype and P (Table 2).

Table 2: Mean square table for maize genotypes tested for P efficiency under field condition in Bumala and Maseno

Source of variation	d.f.	GY	PH	EH	SILK	TASS
SITE	1	109.712***	911121***	273537.4***	3.98	150.1**
GENOTYPE	59	5.5897***	305881***	24345.9***	244.31***	196.08***
P	1	16.3042***	157049***	85166.5***	1520.22***	1535.74***
SITE.GENOTYPE	59	1.7929***	326699***	3643.7***	65.19***	52.36***
SITE.P	1	4.3532***	12386***	182261.1***	49.31	186.74**
GENOTYPE.P	59	1.0631***	5337***	2142.7***	30.77	32.62

SITE.GENOTYPE.P	59	0.5285	9449***	3679.4***	37.05	23.42
Residual	239	0.3874	1218	475.3	5.7	27.46
Total	478					
MEAN		2.119	148.03	50.07	73.54	68.42
SE		0.6224	34.904	21.801	5.694	5.241
CV		29.4	4.2	13.5	7.7	7.7

Note \*, \*\* and \*\*\* indicates significance at  $P \leq 0.05$ ,  $P \leq 0.01$ ,  $P \leq 0.001$  levels, respectively.

With regard to the performance of the single crosses across the sites in P0 5.6% expressed a GY of 1.0-1.49 t/ha, 27.8% expressed a GY of 1.5-2.0t/ha, 30.6% expressed a GY of 2.0-2.49t/ha, 25% expressed a GY of 2.5-3.0t/ha, 11.1% expressed a GY of 3.0-3.49t/ha. This performance was better than the parental lines that had 8.7% expressing 0-0.49 t/ha, 26.1% expressing 0.5-0.99 t/ha, 30.4% expressing 1.0-1.49 t/ha, 13.0% expressed a GY of 1.5-2.0 t/ha, 17.4% expressed a GY of 2.0-2.49t/ha, 0% a GY of 2.5-3.0t/ha, and 4.3% expressed a GY of 3.0-3.49t/ha. On the other hand, all the single cross hybrids expressed a GY of greater than 1t/ha under 26kg/ha P, while only 47.82% of the parental inbred lines expressed the same grain yield under 26kg/ha P, and majority of the parental inbred lines (52.18%) expressed a grain yield of below 1t/ha under 26kg/ha P

(Figure 1

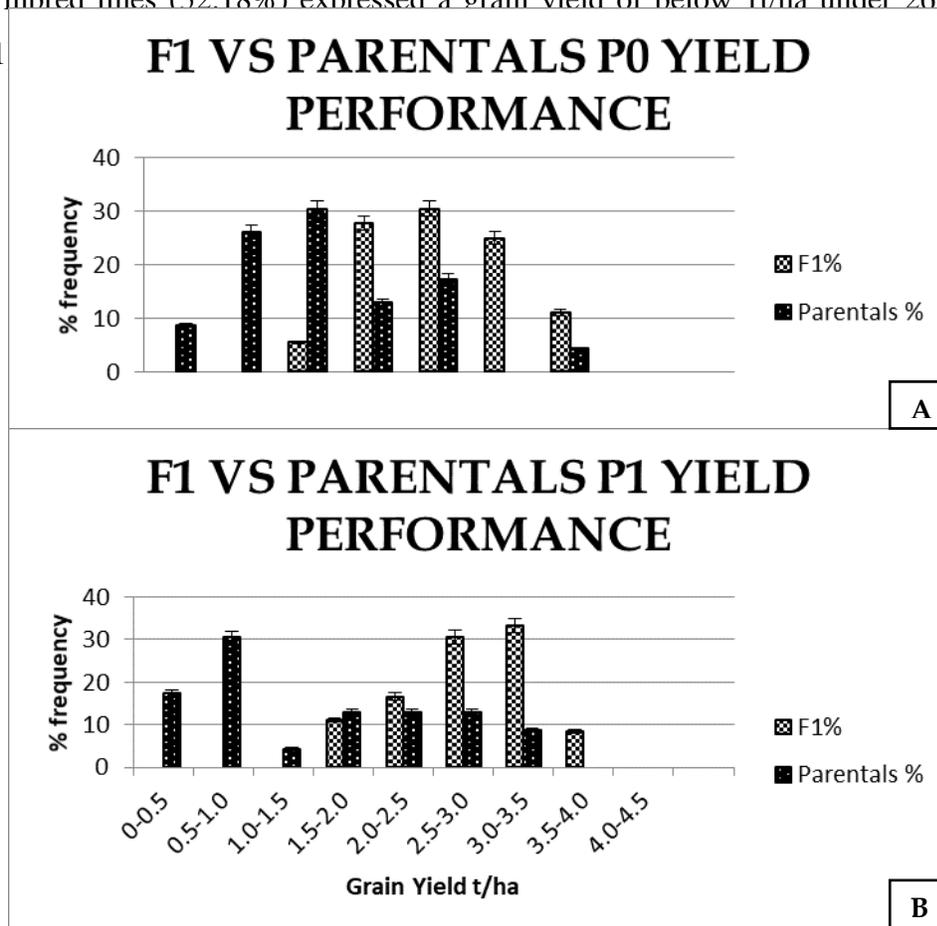


Figure 1: Performance of F1 and Parental lines across P treatments; A (0kg P/ha), B (26kg P/ha)

The best single cross in Maseno under low P (P0) was 4BXSYNAL with a GY of 5.4 t/ha, and the worst was 13MAK-13BXKML036 with a GY of 0.94 t/ha. Under high P (P1), the best single cross in Maseno was 4BXSYNAL with a GY of 6.23t/ha, and the worst was 13MAK-13BXKML036 with a GY of 1.90 t/ha. The best single cross in Bumala under low P was 203B-9X54B with a GY of 1.2 t/ha, while the worst was 203B-9X4B with a GY of 0.09 t/ha. Under high P the best single cross in Bumala was 1BXBRC with a GY of 2.1 t/ha and the worst was 9BXCON5 with a GY of 0.46 t/ha. Across the two sites, the best single cross under low P was 4BXSYNAL with a GY of 3.3 t/ha, while the worst single cross was 13MAK-13BXKML036 with a grain yield of 1.10. Under high P, the best single cross across the sites was 4BXSYNAL with a GY of 4.42 t/ha and the worst was 13MAK-13BXKML036 with a grain yield of 1.75 t/ha (Table 6). Comparatively, addition of P had a 21.1% incremental effect on the grain yield of the single cross F1 used in the study, with a 7.1% increase of grain yield in Maseno and a 29.1% increase of grain yield in Bumala due to addition of P. Also, the overall grain yield for the F1 hybrids in Maseno was 38.5% higher than in Bumala. In addition, the addition of P had a significant effect in improving ear height (EH) and plant height (PH), as well as reducing the days to 50% tasseling, and reducing the days to 50% silking. The single cross hybrids were further classified into different categories (tolerance to low P soils, and responsiveness to P) based on their grain yield at the different P levels. The classification resulted in the conclusion that 97.1% were efficient, 17.65% were responsive to P, and 14.71% were both P efficient and responsive (Table 6).

Table 3: Means for traits under low P and High P in acidic soils of Maseno and Bumala.

Means across the same row with different letters differed significantly

Trait Measured	P0	P1	MEAN	SED
Grain yield	0.421 <sup>a</sup>	1.054 <sup>b</sup>	0.737	0.369
Plant height	114.12 <sup>a</sup>	151.6 <sup>b</sup>	132.86	13.817
Ear height	28.31 <sup>a</sup>	51.72 <sup>b</sup>	40.01	8.118
Days to 50% tasseling	69.82 <sup>a</sup>	65.14 <sup>b</sup>	67.48	3.98

Days to 50% silking	75.56 <sup>a</sup>	71.31 <sup>a</sup>	73.43	4.644
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Table 4: Means for traits across sites (Maseno and Bumala). Means across the same row with different letters differed significantly

	Maseno	Bumala	MEAN	SED
GY	2.597 <sup>a</sup>	1.641 <sup>b</sup>	2.119	0.6224
PH	165.81 <sup>a</sup>	130.24 <sup>b</sup>	148.03	34.904
EH	59.82 <sup>a</sup>	40.32 <sup>b</sup>	50.07	21.801
Days to 50% tasseling	68.98 <sup>a</sup>	67.86 <sup>a</sup>	68.42	3.98
Days to 50% silking	73.45 <sup>a</sup>	73.63 <sup>a</sup>	73.54	4.644

Phenotypic relationships among maize performance indicator traits across sites

GY had a strong and positive correlation with both EH ( $r=0.82$ ) and PH ( $r=0.80$ ) for the all genotypes in the study. Also, PH and EH had strong positive correlation ( $r=0.82$ ) for all the genotypes in the study. For the inbred lines, correlation between GY and EH, GY and PH, and EH and PH was strong and positive at ( $r=0.87$ ), ( $r=0.93$ ), and ( $r=0.96$ ) respectively. For the single cross hybrids, correlation between PH and EH was positive and strong ( $r=0.86$ ), correlation between PH and GY was moderate and positive (0.61), while correlation between EH and GY was weak and positive (0.45). For all the genotypes in the study, GY had a positive and insignificant correlation with days to 50% tasseling ( $r=0.01$ ) and with days to 50% silking ( $r=0.09$ ), this was similar to the F1, where GY had a positive yet insignificant correlation with days to 50% tasseling ( $r=-0.06$ ) and with days to 50% silking (0.17). For the inbred lines correlation between GY and days to 50% tasseling ( $r=0.41$ ), and GY and days to 50% silking ( $r=0.50$ ) was moderate and positive (Table 4).

Table 4: Correlation between GY, EH, PH and days to 50% flowering of all genotypes tested for P-efficiency in Maseno and Bumala.

Grain	Plant	Ear	Days to 50%	Days to 50%
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	Yield	height	Height	Tasseling	Silking
Grain Yield	1				
Plant height	0.8**	1			
Ear Height	0.82**	0.82**	1		
Days to 50% Tasseling	0.01	0.15	0.25*	1	
Days to 50% Silking	0.09	0.3	0.39*	0.92**	1

\* and \*\*; Significance at 5 and 1%, respectively.

Table 5: Table with Selected F1s for grouped for P efficiency and response to P based on Grain yield means.

GENOTYPE	Grain			
	Yield		Response to P	
	P0	P1	P1/P0 (R)	Categories
4BXSYNAL	3.34	4.42	1.33	EN
54BXBRC	3.20	2.88	0.90	EN
9BXSYNAL	3.18	3.44	1.08	EN
203B-9X54B	3.14	3.01	0.96	EN
44BX203B-9	2.89	3.06	1.06	EN
44BX203B-14	2.85	2.73	0.96	EN
41BX203B	2.69	2.36	0.88	EN
4BX203B-1	2.65	2.28	0.86	EN
41BXCON5	2.31	2.74	1.19	EN
13BX203B-14	2.17	3.67	1.69	ER
203B-9X4B	2.13	3.24	1.52	ER
41BXBRC	1.59	3.76	2.36	IR
1BXBRC	1.57	3.54	2.25	IR
1BXAO809	1.53	1.96	1.28	IN
13BXKML036	1.10	1.75	1.59	IR

KEY: I, Inefficient; R, Responsive, E, efficient; N, non-responsive; IR, inefficient and responsive; ER, efficient and responsive; EN, efficient and nonresponsive; IN, inefficient

and nonresponsive.

## DISCUSSION

### (i) Variation in agronomic traits due to P addition, genotypic differences, and site.

The genotypes and P treatments had a significant effect on the plant height, ear height, grain yield, and days to flowering of the genotypes in the study. At Bumala the addition of P led to an overall increase in grain yield by 29.1%, plant height by 24.7% and ear height by 45.8% but reduced days to 50% tasseling by 7.2% and days to 50% silking by 5.6%. In Maseno, grain yield was increased by 7.1%, plant height by 0.42% and ear height by 8.8%, days to 50% tasseling and days to 50% silking reduced by 3.4% and 4.1% respectively due to the addition of P. This effect of P in improving agronomic crop traits identified in this study relates well with other studies. Fosu-Mensah & Mensah (2016), Ouma *et al* (2013), Umeri *et al* (2016) reported that the addition of P resulted in a reduction of days to flowering (tasseling and silking), as well as an increase in grain yield. According to Ouma *et al* (2013), P addition at 26kgP/ha resulted in a grain yield increase by a margin of 73.5%, as well as a corresponding increase in ear and plant height. Besides these findings, Lokhande *et al* (2015) concluded that an increase in wet and dry biomass, as well as increased plant height for Coriander due to application of P at 45kgP/ha. Also, Alias *et al* (2003) concluded a 15% increase in plant height and a 53.76% increase in grain yield due to P supply at 150kgP/ha for maize. On the other hand, Dai *et al* (2013) reported a yield loss of 560kg/ha/year for maize due to lack of P fertiliser thus indicating the mineral's importance to improve grain yields for the crop.

In addition, the different genotypes expressed varied grain yield response due to P addition. This could have been due to inherent genetic differences in acquiring P from the soil. These results are similar to those reported by Fosu-Mensah & Mensah (2016) as well as Ouma *et al* (2013) and Umeri *et al* (2016), who reported that genetic differences among genotypes contributed to variance in acquisition and utilization of soil P. Although the grain yield at Maseno was better than Bumala the effect of P addition was marginal at Maseno as compared to Bumala. This difference may be due to the higher soil P, variation in response to added P at 26kgP/ha at the two sites, and higher soil pH at Maseno as compared to Bumala. These results are comparable to those of (Kihara, 2016) who reported variation in the effect of NPK fertiliser on grain yield across sites. The soils in

these two regions also expressed a variation in organic carbon content with Maseno having a slightly higher level. High organic carbon is known to increase the soil CEC which affects retention of cation nutrients, as well as improving water infiltration and retention (Noellemeyer & Six, 2015). In addition to the soil issues, the variation in rain fall received by these two regions may also have affected overall grain yield.

The reported improvements in plant grain yield and yield components due to the addition of P can be ascribed to its role in the development of plant roots as these are the main water and mineral absorption organs. In addition, P is essential in photosynthesis, cell division and elongation, and being synergistic to Nitrogen absorption (Ouma *et al.*, 2013; Salehi & Anampanah, 2015). Despite the improved yields due to P addition, the overall yields of the genotypes in the study at Bumala neither met the 3t/ha threshold set by Gudu (2011), nor did they meet 3.41-8.7t/ha threshold set by Ouma *et al* (2012). These results can be attributed to the prolonged drought at Bumala during the experimental season that also interacted with late flowering for some of the genotypes. According to Halindu (2015), prolonged drought can cause yield losses of between 50-100% depending on the length of the scourge. At the study site in Bumala, nearby fields and the farmer's field had visible effects of the drought with losses of up to 100% for some of the neighbouring farms.

(ii) Phenotypic relationships among maize performance indicator traits across sites

PH and EH had a positive and significant correlation to each other as well as to GY. These results are in agreement with those of Appiah *et al* (2014). Such positive correlation presents that these yield components are associated positively with GY and can be used effectively in selection purposes for GY (Akongwubel *et al.*, 2012). Between grain yield and flowering the general correlation was positive but weak and insignificant for all the genotypes in the study and for the F1s. These findings are similar to those reported by Yousuf and Saleem (2001). However, the correlation between grain yield and flowering dates was positive and moderate for parental inbred lines, where GY and days to 50% tasseling ( $r=0.41$ ), and GY and 50/5 silking ( $r=0.50$ ).

## CONCLUSION

The study identified 23 P efficient single crosses and 11 inefficient single crosses. Of the

efficient single crosses, only two were responsive to P addition, while of the inefficient three were responsive to P addition. These genotypes can therefore be utilized in further development of three way and top crosses for P efficiency as well as gene pyramiding to develop multiple tolerant maize genotypes. Also, genotypic variability for P efficiency and response to P was identified among the maize genotypes in study and was further enhance by soil fertility variation among the sites.

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**Influence of Cluster group Extension approach on Cotton Production among  
Smallholder Farmers in Bura Irrigation and Settlement Scheme, Kenya.**

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**ABSTRACT**

Kenyan smallholder cotton production has remained low despite the spirited effort by the government and private sector to revive the sector. Several factors combined seem to be responsible for this perpetual low production. Among the factors are constraints ranging from, inadequate extension services, limited access to information on production and poor marketing systems. The purpose of this study was to investigate how Cluster group extension approach influence cotton production among smallholder farmers in Bura Irrigation and Settlement Scheme. The study utilized descriptive survey research design to collect data from farm households on the influence of selected factors on cotton production, while secondary data was collected from Cotton Development Authority and National Irrigation Board offices in Bura Irrigation and Settlement Scheme. The study population was all smallholder cotton farmers in Bura Irrigation Scheme. Proportionate simple random sampling method was used to select 120 farmers from 1022 cotton farmers in 11 villages within the scheme, who were included in the study. A validated questionnaire was used to collect data. Descriptive and inferential statistics was used to analyze the data to determine association and relationships using Statistical Package for Social Science (SPSS) version 20.0. The findings showed that most of the respondents (71%) indicated that they belonged to a cluster group, 77.5% seek for farm production advice from other farmers. On farm visits by extension officers, 91% of the respondents indicated that they were never visited by the extension officers during the last production year. Further analysis reveals that majority of the respondents (56%) were in agreement that Cluster group approach to extension services is the most ideal for reaching out to farmers within the Scheme.

**Keywords:** Cluster group Extension Approach, Cotton Production, Cotton Seeds, Seed cotton, Smallholder.

## **1. Introduction**

Cotton is the largest revenue earning of the non-food crops produced in the world. Its production and processing provide some or all of the cash income of over 250 million people worldwide, including almost 7 percent of the available labor force in developing countries (International Cotton Advisory Committee [ICAC], 2014). These activities are becoming highly concentrated over time; today, 77 percent of global cotton output and 73 percent of the cotton hectares are accounted for by China, the United States, India, Pakistan, and the Central Asian Republics. India accounts for approximately 21 percent of the world cotton area but the average productivity of cotton is markedly low, at about 293 kilograms of lint cotton per hectare compared to 600 kg per hectare of world average per year (Sen, 2013).

Cotton production faces crucial challenges such as: escalating costs of production, low cotton prices, inefficient pest management, stickiness, yield variability within the same location, late cotton picking, subsidies in the developed countries, diminishing production capital and competition from other crops. These obstacles diminish the benefits from continuing cotton cultivation (International Cotton Advisory Committee [ICAC], 2015). Even though the challenges are numerous, all the parties involved in cotton production are optimistic that Kenyan cotton will regain and even surpass its former position through the enhancement and implementation of site-specific and low-input technologies. Significant improvements in institutional, policy and financial aspects must also be made in order to achieve competitiveness in the global economy. These challenges have to be taken up by the whole spectrum involved in the cotton sector, that is, researchers, extension workers, production agronomists, economists and policy makers (Kenya Institute for Public Policy Research Analysis [KIPRA], 2016).

According to ICAC (2014), poor yields from smallholder cotton in Africa have been a long standing problem that has not been greatly altered by release of new varieties or by other recommendations made on the basis of research findings and consequently there seems to be a number of problems in translating the outputs from research into the farmers' fields; farmers are consistently not taking up the recommendations. In response

to African Growth and Opportunity Act (AGOA) and the expectation of declining cotton subsidies in developed countries, a number of Sub-Sahara African countries are embarking on programmes to stimulate cotton production. The focus is mainly on the provision of subsidized seed, fertilizer and insecticide but missing factors are both the development of sustainable integrated crop management practices and similarly sustainable mechanisms for the delivery of technical support services to the producers (ICAC, 2015). In South Africa, relatively low prices, high input costs, exchange rates, cheap import of cotton fibre and international subsidies are all factors affecting cotton production negatively (Cotton, 2014).

The Kenya's cotton sector performance declined substantially in the 1990's at the height of trade liberalization; both cotton production and the textiles garments industry suffered due to continued synthetic fibre competition, diminishing world prices, introduction of cheap imports of second hand clothes and diminished cotton profitability aggravated by inefficiencies in the production system and supply side constraints . The decline in cotton production in the last two decades has also coincided with increase in poverty levels in areas designated as major cotton belts. The gradual cotton decline has also affected other parts of the value chain including ginners, textile mills and manufacturers (Institute of Economic Affairs [IEA], 2014).

Cotton in Kenya is mainly grown by small-scale farmers in marginal and arid areas, on small land holdings. It is estimated that Kenya currently has 90,000 small-scale cotton farmers compared with over 200,000 farmers in the mid-1980s when the industry was at its peak (CODA, 2015). The Cotton Board of Kenya estimates that countrywide, 350,000 hectares is suitable for rain-fed cotton production with the potential to produce about 260,000 bales of lint annually, and 34,500 hectares for irrigated cotton with the potential to produce 108,000 bales of lint annually. However, only about 25,000 hectares is currently under the crop, and the total annual lint production stands at only about 20,000 bales (CODA, 2015).

Despite these efforts, issues affecting cotton production have not been adequately

addressed as most of the cotton production regions are yet to embark on its production despite the local markets available for the same. Given that the average yield is only 500 kg/acre profitability would be greatly improved even with production at 50% of the yield potential of the commercial varieties (Wakhungu & Wafula, 2013).

Kenyan cotton is produced under both irrigated and rainfed conditions. In Bura Irrigation and Settlement Scheme where the study was conducted, cotton is the major crop which is grown in rotation with maize (National Irrigation Board [NIB], 2015). According to Cotton Lint and Seed Board [CL&SB] (1992), by 1985, Bura Irrigation Scheme was responsible for 45% of the total country's cotton production where on farm average production stood at 3,600 kg/acre of seed cotton and thus, the Scheme was recognized as the pillar of cotton sector in Kenya. The current average seed cotton production in the scheme stands at 1,000 kg/acre against the potentials of 4,000 kg/acre under irrigation of the current HART 89M variety grown (Waturu, 2014). Currently, the area under cotton production stands at 1,800 acres against the potential of 16,000 ha of land which has been opened up by National Irrigation Board and is under irrigation (NIB, 2015).

One strategy for lowering the cost of cotton production would be to increase yields, which currently stands at about 21% of the potential for the varieties grown in Kenya (Kenya Agricultural Research Institute [KARI], 2014). However, according to Cotton Development Authority [CODA] (2015), cotton production in Kenya is currently faced by constraints ranging from erratic weather patterns, weak cooperative movement, high cost of inputs, lack of rural credit, poor seed quality, inadequate extension services and inappropriate extension approaches and poor marketing systems. CODA (2016) further indicated that efforts to release a new variety of genetically modified cotton seeds to farmers has been halted by the government's ban on genetically modified organisms, consequently farmers have to wait a little longer to benefit from the recent break through.

## **2. Research Methodology**

Descriptive survey research design was used for the study. Descriptive survey research design was appropriate for this study because it allows one to obtain information concerning

the current status of the phenomena to describe ‘what exists’ with respect to variables or conditions (Mutai B. K., 2013).

The study was carried out in Bura Irrigation and Settlement Scheme of Tana River County, Kenya. Bura Irrigation Scheme is located in Tana River County. The scheme is situated on the right bank of River Tana within the lower Tana River basin. The population for this research was all cotton producing households in Bura Irrigation and Settlement Scheme. A sample of 120 farmers was sampled for the study. A sample size of 120 respondents was considered appropriate for the study as it was above the minimum recommended sample size of 100 in consideration of the level of accuracy required and the accessible population (Mutai B. K., 2013). The extra number of 20 households was to cater for dropouts and non-respondents during the study. Proportionate simple random sampling was used to select the farmers to be studied from each of the Villages. With the aid of table of random numbers, participating farmers were identified where the sampling unit was the head of the household. A questionnaire was developed along the objectives and used to collect data from farmers (research participants). Secondary data was collected from National Irrigation Board and Directorate of Fibre Crops offices at Bura Irrigation and Settlement Scheme.

Data from questionnaires was organized, collated and coded for possible errors according to study objective and variables. Summarized data was keyed into the computer for analysis using Statistical Packages for the Social Sciences (SPSS) version 20.0. Descriptive and inferential statistics was used to analyze the data, multiple regression analysis model was used to determine the extent of the influences of the various independent variables on cotton production among smallholder farmers.

### **3. Results and Discussions**

The study sought to determine the influence of cluster group’s extension approach on Cotton production in Bura Irrigation Scheme. The study investigated membership of the farmer in a cotton farmer group, who is turned to for advice whenever faced with a problem on the farm, frequency of visits to the farm by Extension Officers, availability of extension workers when needed, training received on cotton production in the recent past and their influence on cotton

The respondents were asked whether they were members of any cotton farmers' group and the reasons for or against belonging to a group. The results of the investigation are presented in Table 1 and 2.

**Table 1: Group Membership**

Membership	Group Membership	
	Frequency	Percentage
Yes	85	71
No	35	29
<b>Total</b>	<b>120</b>	<b>100</b>

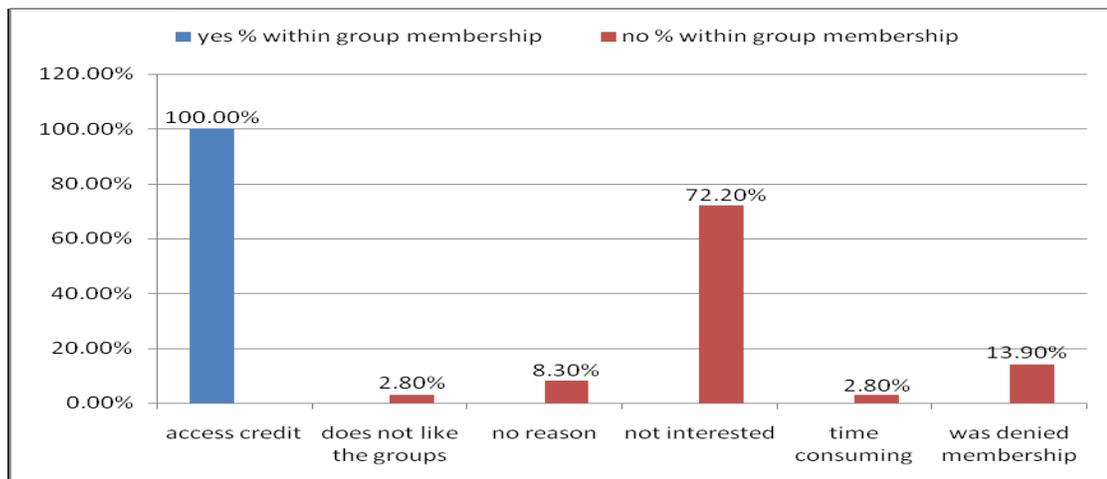
Analysis of results in Table 1 indicate that 71% of the respondents belonged to cotton production groups, and 29% of the cotton farmers did not belong to any one cotton group.

**Table 2: Reasons for group Membership**

Reason	Frequency	Percentage
To access credits from AFC	85	71
Does not like groups	1	0.8
No specific reason	3	2.5
Not interested	26	21.6
Denied Membership	4	3.3
Ejected from a group	1	0.8
<b>Total</b>	<b>120</b>	<b>100</b>

The respondents were further requested to give reason for either being or not being in cotton group, where 71% indicated that the main reason is to access credits from AFC, while 22% indicated that they were not interested in joining any group as 7% cited other varied reasons (Table 2).

All those belonging to groups (100%) cited access to credit from AFC as the major motivating factor. On the other hand those who did not belong to any group pointed a number of reasons key among them was that 72% indicated they were not interested in joining any group (Figure 1).



**Figure 1: An illustration of Cotton group membership by the respondents**

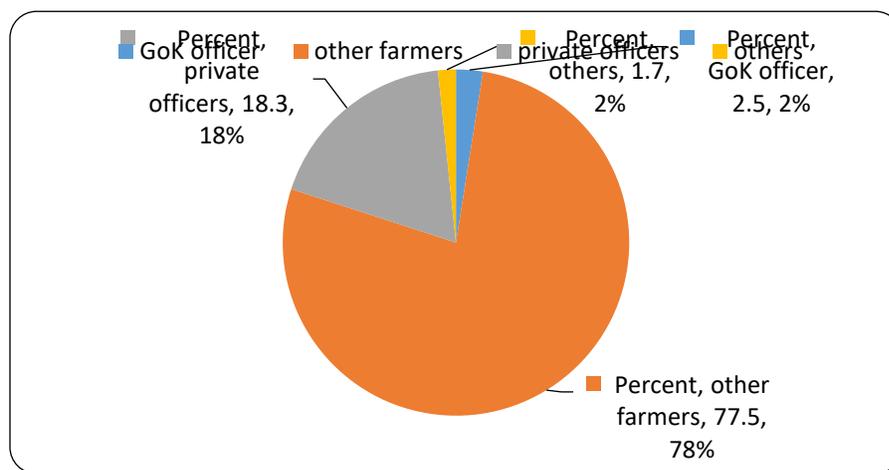
The respondents were requested to indicate the various sources they sought assistance on cotton production whenever they are faced with problems. The results of the investigations are presented in Table 3

**Table 3: Sources of Farm Advice**

Source	Frequency	Percentage
GoK Extension Officers	3	2.5
Other farmers	93	77.5
Private Officers	22	18.3

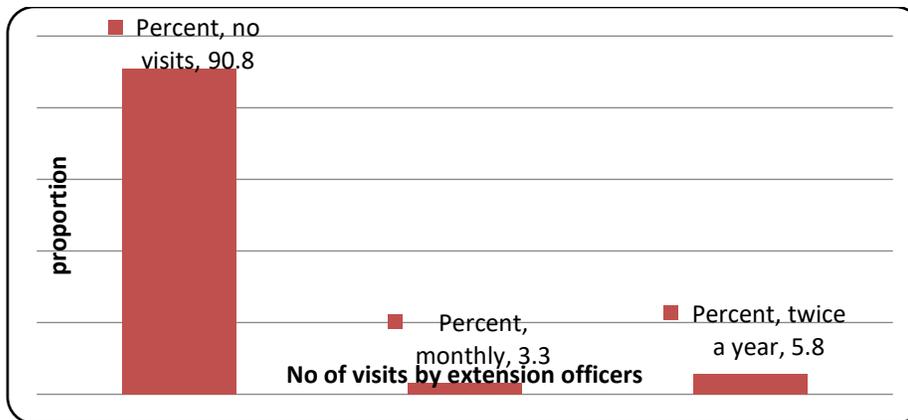
Others (CBOs)	2	1.7
<b>Total</b>	<b>120</b>	<b>100.0</b>

All the respondents indicated that they seek for advice whenever they are faced with challenges during cotton production from various providers. 77.5% of the respondents indicated that they seek assistance from other farmers while 18.3% obtain services from private service providers and only 2% who seek assistance from Government Extension Officers (Figure 2)



**Figure 2: Farmers sources of advice during cotton production**

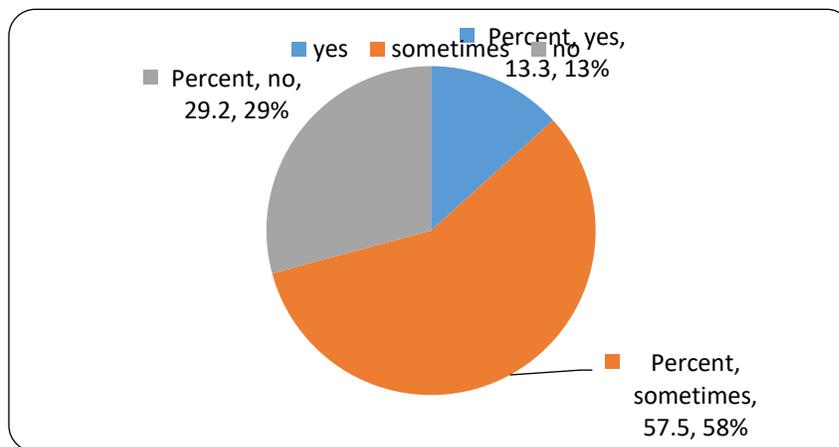
Asked about the extension officer's visit to their farms, 90.8% of the respondents indicated that they have never been visited by these officers, 3.3% had at least a visit in a month and 5.8% were visited once in a year (Figure 3).



**Figure 3: Frequency of visits to cotton farmers by extension officers**

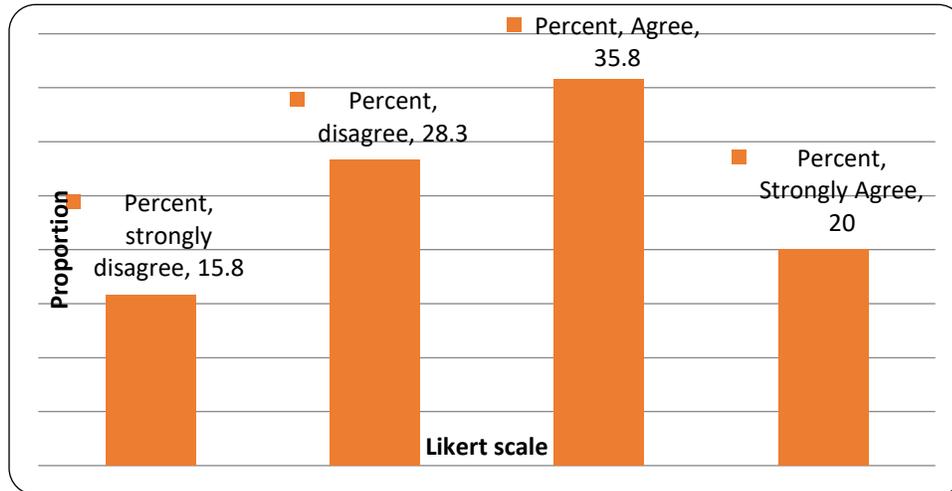
Probably, this could be an explanation as to why majority of the respondents indicated that they seek assistance from fellow farmers whenever confronted with cotton production challenges.

To establish whether extension officers were available when demanded, 29% of the respondents indicated that the officers were not available on demand, 58% indicated that the Officers were sometimes available as only 13% indicated that the officers were always available when demanded. (Figure 4)



**Figure 4: Proportions of respondents on the questions of availability of officers on demand**

With the use of a likert scale, the respondents were required to state whether cluster group method is the most ideal for reaching out to cotton farmers. The proportion of those who strongly disagreed was 15.8% as opposed to 20% of those who strongly agreed. (Figure 5)



**Figure 5: Proportions of Cluster group approach to extension services**

Further analysis reveals that majority of the respondents (56%) were in agreement that Cluster group approach to extension services is the most ideal for reaching out to farmers within the scheme. According to the analysis of the data, it is clear that most of the farmers prefer this approach where, a cumulative 56% of the respondents confirmed that it was the ideal approach as opposed to 44% % of those who disagreed. It is important to note here that the proportion of those who disagreed, although comparatively low is significantly high to warrant attention. For this reason, a hybrid of different extension approaches may be more appropriate in Bura Irrigation Scheme as opposed to cluster group extension method alone. However, according to FAO, 2013, when designing extension services, one should keep in mind not only the relative efficiency gains from each type of extension, but also the constraints that each type faces.

Respondents were requested to indicate whether they have had any training in the recent past and to specify the kind of training if any. Analysis revealed that, 39% of the respondents indicated that they had been trained on cotton production as opposed to 61% who said they had not been trained on cotton production in the recent past (Table 4). All

those who admitted to have been trained had received one training on pest management.

**Table 4: Training on cotton production**

Training on Cotton Production	Frequency	Percentage
Yes	47	39
No	73	61
<b>Total</b>	<b>120</b>	<b>100</b>

Regression analysis was used to determine the influence of cluster group supported extension approach on cotton production for the analysis. The area under cotton during last season (Y) =Constant  $b_0$  + training on cotton production ( $X_1$ )+, person sought for in case of problems ( $X_2$ )+ availability of extension workers ( $X_3$ )+ frequency of visit ( $X_4$ ). ( $Y=b_0+b_1X_1+b_2X_2+b_3X_3+b_4X_4$ ).

The R reflects a weak prediction of the dependent variable (Area under cotton during last season) with a score of 0.223 and  $R^2$  of 0.05 (Table 5). Subsequently, only 5% of variability in the dependent variable can be attributed to the independent variables (training on cotton production, person consulted in case of problems, availability of extension workers and frequency of visit).

**Table 5: Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.223 <sup>a</sup>	.050	.017	.5169

a. Constant: training on cotton production, sources of farm advice in case of problems, availability of extension workers, frequency of visit.

No linear relationship exists between the dependent variable and the independent

variable, this is determined by the F-test;  $F(4, 115) = 1.502, p > 0.0005$  (Table 6)

The model equation for this analysis has been derived from the table 6 below;  $Y = 1.132 + 0.092X_1 + 0.128X_2 + 0.032X_3 + 0.093X_4$ . From the results obtained no individual independent variable can significantly predict the dependent variable which is in this case is the area under cotton production. This is determined by the standardized coefficients in table 6.

**Table 6: Coefficient of independent variables used to determine area under cotton**

Model	Unstandardized		Standardized		95.0% Confidence Interval for B	
	B	Std. Error	Beta	T	Lower Bound	Upper Bound
1 Constant	1.132	.366		3.094	.407	
Frequency of visit	.092	.117	.092	.430	-.139	.323
Source of farm advice	.128	.073	.191	1.760	-.016	
Avail. Of ext. workers	.032	.088	.039	.367	-.141	
Training on cotton	.093	.120	.088	.775	-.145	

a. Dependent Variable: area under cotton during last season

### Conclusion and Recommendations

Most of the farmers support cluster group extension approach as the ideal approach in reaching out to cotton farmers in Bura Irrigation Scheme. However, it is important to note

that the proportion of those who disagreed, although comparatively low is significantly high to warrant attention. For this reason, a hybrid of different extension approaches may be more appropriate in Bura irrigation scheme as opposed to cluster group extension method alone. However, according to FAO, 2013, when designing extension services, one should keep in mind not only the relative efficiency gains from each type of extension, but also the constraints that each type faces.

Cluster group extension approach scored high in terms of effectiveness in delivery of extension services, it could be appropriate to organize and strengthen farmers' groups with a view of using such groups as platforms for extension provision for the small holder farmers, hence its use in the scheme was recommended.

### **Acknowledgement**

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**Effect of Using Different Types of Irrigation Water on the Soil-to-Crop-Transfer Factor in Leafy Vegetables Grown along Peri-Urban Areas of Kiambu County, Kenya**

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**ABSTRACT**

The water used for irrigation has a significant effect on the way heavy elements accumulates in the soil as well as how plants grown on those soils uptake elements. Therefore, this study aimed at establishing the effect of using different types of irrigation water on the soil-to-plant transfer factor for African nightshade (*Solanum Scabrum* Mill) grown in the peri-urban areas of Kiambu County, Kenya. Randomized complete block design was used to grow the crop samples in the field for a period of 30 days. Four types of water (tap water, borehole water, shallow well water and wastewater) were considered as the four treatments and replicated four times. From the results, the level of Cd<sup>2+</sup> and Pb<sup>2+</sup> in the soils which were  $2.63 \pm 0.10$  and  $3.77 \pm 0.10$  ppm respectively was above the World Health Organization (WHO) acceptable limits. For the crop samples that were irrigated using wastewater, a high level of Fe<sup>3+</sup> was recorded  $224.59 \pm 14.59$  ppm though not above the WHO limits. The soil-to-crop transfer factor values (TF) for crops grown using shallow wells had a value >1, an indication that this type of water positively influences the uptake of these elements. The TF values for Cd<sup>2+</sup> AND Pb<sup>2+</sup> IN crop samples grown using tap water were < 1 at 0.95 and 0.97 respectively which signify the ability of tap water to suppress uptake of heavy elements by plants. Based on the results, it is notable that the quality of water used for irrigation affects the way in which plants accumulates elements from the soils. It is recommendable for policy makers in the study area to educate the farmers on the need to carry out phytoremediation as one of the innovative risk-reduction interventions measures in regard to bioaccumulation.

Key terms: Soil-to-plant transfer factor (TF), World Health Organization (WHO), Tap water, Borehole water, Shallow well water and Wastewater.

## Introduction

Soils from fields that are irrigated using wastewater have high probability of being contaminated with heavy metals, thus posing a threat to humans. This is due to the premise that wastewater irrigation results to increased total and phytoavailable heavy-metal concentrations in the soils. Consequently, heavy-metal elements in the soils are taken up by plants and undergo sequestration in various parts of the plants such as the roots, leaves and stems. Therefore, the heavy elements are able to accumulate on those parts thus readily available for consumption by humans and animals, a factor which results to bioaccumulation. However, it is worth noting that the factors which affects the form and solubility of available species of metal in soil varies significantly depending on the soil properties (mineralogy, endogenous metal concentration, particle size distribution), chemical form of elements that are entering the soil, soil processes (microbial activity, mineral weathering) (Lepp, 2012). By determining the soil-to-crop transfer factor, one can be able to evaluate the amount of elements that are in the soil and readily for uptake by plants. The soil-to-crop transfer factor (TF), or uptake factor, is regarded as one of the most important parameters used for evaluating the transfer potential of a metals and radionuclides from soil to plant. This is based on the fact that plants are the primary recipient of heavy metals and radioactive contamination to the food chain from the abiotic environment through uptake from the atmosphere by above ground parts and sorption from the soil by the root system of plants (Gupta & Walther, 2014). TF is calculated as:

$$TF = \frac{\text{the Metal concentration in the edible part of the vegetable}}{\text{Metal concentration in the media sample}}$$

The metal concentrations in the extracts of the soils and plants are calculated on the basis of dry weight. If the ratios >1, the plants have accumulated elements, the ratios around 1 indicate that the plants are not influenced by the elements, and ratios < 1 show that plants exclude the elements from the uptake. If the plants have higher TF values, they can be used for phytoremediation. Vegetables grown on contaminated soils accumulate high concentrations of heavy metals in their edible parts. This is based on the ability of vegetables to uptake and translocate heavy metal elements in different parts, factor which may lead to more concentration of a particular element in the plant as compared to the leaves (Olowoyo et al. 2010).

It is important also to note that the TF values of heavy metals and radionuclides vary enormously depending on the type of soil, crop as well as the duration a particular element has been in the soil. Other factors are crop variety, agricultural practice (especially applying fertilizer) and differences in the weather during the growing season as summarized by the figure below.

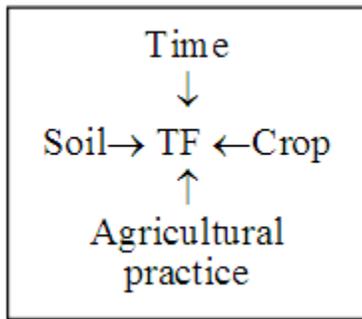


Figure 1: **Main factors affecting TF values**

In this study on accumulation of heavy metal in the edible parts of some cultivated plants in Southern Turkey, Saglam (2013) established that the TF values of Molybdenum was the highest in all crop samples tested (*R. sativus*, *B. oleracea*, *V. unguiculata* and *P. vulgaris*) with *V. unguiculata* and *B. oleracea* having a value of 11.67 and 3.90 respectively. Similarly, *R. sativus* had a high TF value of 1.345, 1.336 and 0.692 in regard to cadmium, Cobalt and Zinc accumulation as compared to the other vegetables grown in the area. For this study, African nightshade (*Solanum Scabrum*) was selected as the leafy vegetables to evaluate the ways in which soils colloids influence the uptake of elements in vegetables grown around Kiambu County Kenya. The various species of the African nightshade grown in Kiambu County have become popular as they contain high level of proteins, iron among other nutrients as compared to the traditional vegetables such as kales. As noted by Muthomi & Musyimi (2009), the composition of 100g edible portion of *S. Scabrum* Mill is 87.8 g of water, energy 39 kcal (163 kJ), protein 3.2 g, carbohydrate 6.4 g, fat 1.0 g,  $\beta$ -carotene 3.7 mg, Ca 200 mg, ascorbic acid 24 mg, fibre 2.2 g, Fe 0.3 mg and P 54 mg. There are also high levels of vitamin A, B and C and alkaloids and phenolics in the leaves. Based on this, a diet that incorporates African nightshade is significantly recommendable to nursing or pregnant mothers as well as those having iron deficiencies. It is based on this that this study aimed at establishing the

effect of using different types of irrigation water on the soil-to-plant transfer factor for African nightshade (*Solanum Scabrum* Mill) grown in the peri-urban areas of Kiambu County, Kenya. The four types of water used for this study were wastewater, water from borehole water, water from the shallow wells and municipal water (tap water).

**Borehole-** It is a narrow shaft bored in the ground, horizontally or vertically and having a depth of between 25 to 1000 feet (Preene, 2012).

**Tap water-** Tap water also referred to as municipal water, city water, running water or town water is water supplied to a tap (valve) (Salzman, 2013).

**Wastewater-** Any type of water whose quality has been adversely affected by anthropogenic influence (World Health Organization, 2016)

**Shallow well** –A well that has a depth of 25 feet and below (Preene, 2012).

## 2.0 MATERIALS AND METHODS

### 2.1 Study area

The study area, located in Kiuu Ward Githurai area, lies between 1°11'59.43"S and 36°56'00.03"E. The area was selected due to accessibility as well as availability of land for carrying out the experiment. It is notable that the area is rapidly growing as it has an elaborate means of transport, both the Kenya-Uganda Railway and Thika Road Super Highway, a factor which has attracted many people to invest in this area. Majority of people residing in this area work for the City of Nairobi (Chege, 2011). The area has around 100 farmers mainly growing *S. Scabrum* among other leafy vegetables. There is also availability of market along the study area due to its proximity to the Githurai open air market located between 36°54'49.77"E, 1° 12'10.07"S and 36°55'10.62"E, 1°12'10.21"S, thus encouraging increased farming of *S.Scabrum*. In the study area, there are two rainy seasons: the long rains which fall between April and mid-June and short rains in which fall in November and early December. According to the Kenya Meteorological Department, in Githurai area, the average annual rainfall is approximately 900 mm, although this varies from one year to the other. Due to its proximity to the

equator, the average daytime temperature varies slightly from 29°C (85°F) in dry seasons and 24°C (75°F) during the rest of the year. The strongest winds take place during the dry season just before the "Long Rains" at a speed of between 20 and 25 m.p.h (Kenya Meteorological Department).

According to the 2009 Kenya Population and Housing Census, the total population in Githurai Location was 103,045 and was projected to rise to 120,906 by 2015. Similarly, the total number of households was 33,185 by 2009, all in an area of 32.2 sq.km. Since Githurai came up as a result of land being subdivided without following any guidelines, the area is highly unplanned in regards to sewerage system, road reserves and a system to manage solid waste. The area is congested as a result of huge number of tenements that are being built with the aim of taking advantage of increasing population (Chege, 2011). In regard to soils and geological formation, the area contains tertiary volcanic rocks, the most critical one being what is regarded as Nairobi Stone. Nairobi Stone, mostly used for building, is a tertiary volcanic rock, which gives to soils that are dark reddish brown, friable, well drained and highly calcareous. In geological terms, soils in the study area are youthful soils, with patches of black cotton soils. However, majority of the soils possess a high safe-bearing capacity, thus being able to support foundations for buildings at even shallow depths. As a result, the vegetation in Githurai area is mainly comprised of shrub vegetation as this is what the soils can support (Kamau, 2012).

## **2.2 Preparation, Collection and Laboratory Analysis of the Crop Samples**

Randomized complete block design was used to grow the crop samples in the field for a period of 30 days. The four types of water (tap water, borehole water, shallow well water and wastewater) were considered as the four treatments and replicated four times as shown by figure 2. After the 30<sup>th</sup> day, complete harvest was done where only the mature leaves were randomly selected and placed in brown papers bags and transported to the laboratory for analysis.

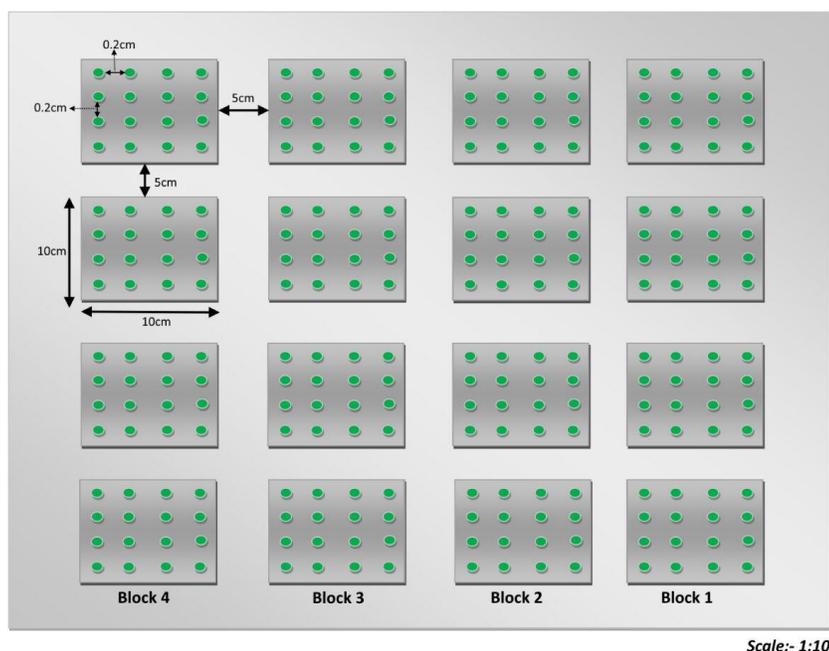


FIGURE 3.3: LAYOUT OF THE EXPERIMENTAL AREA

Source: (Author)

In the laboratory, all the crop samples were first washed under running tap water with the aim of removing dust particles that may interfere with the results from analysis. Subsequently, the samples were washed with acidified distilled water (1ml Conc. HCL/Liter), and then rinsed thoroughly with distilled water (Masabni, 2015). An oven was used to dry all the samples at approximately 70° C for a period of 24-48 hours. Since the water content in each sample varies significantly, their weights were noted throughout. They were regarded as dry when the weight was constant for two consecutive readings. After drying, the plant samples were ground in order to pass a 1.0-mm screen (20 mesh), as the sample aliquot assayed was >0.5 g (Molina, 2011). The samples were then mixed thoroughly and transferred to polythene bags, labeled clearly and stored.

One gram of plant tissues from every sample was carefully weighed and put in 100 ml volumetric flask. 5 ml of acid mixture (HNO<sub>3</sub> and HClO<sub>4</sub> and mixed in the ratio of 2:1 respectively) were added to the each crop sample. The solution was then heated by the use of hot plates for 15 minutes in a fume chamber at 60 °C until the reaction was complete. Thereafter, the samples were heated at 120 °C for 75 minutes until the liquid

turned colorless. They were then removed from the hot plates, cooled, transferred to a volumetric flask (100 ml) and distilled water used to fill it to the mark and filtered using Whatman No. 1 filter paper. Through use of the Atomic Absorption Spectrophotometer (AAS), the level of concentration of copper, lead, iron, zinc, manganese and cadmium were obtained from the samples.

## **2.2 Preparation, Collection and Laboratory Analysis of the Soil Samples**

Soil samples were collected from all the four blocks by the use of a soil auger. The samples were randomly collected in triplicates at a depth of between 10 and 25 cm and stored in brown sugar bags each weighing 0.5 kg. They were clearly labeled by the use of a marker pen and transported to the laboratory, where they were air dried for two days. All the samples were then crushed to pass a 2mm sieve prior to various laboratory tests.



Figure 2: Air drying the soil samples

In testing the seven selected elements Melich Double acid extraction method was used. By use of this method, the soil samples collected before transplant ( $T_0$ ) and at the time of complete harvest ( $T_1$ ) were extracted with a double acid extracting solution (0.1 N HCl and 0.025 N  $H_2SO_4$ ). The soil samples were dried crushed and sieved using a 2 mm sieve.

5g of each soil sample was separately treated with the double acid solution, a mixture of 0.1 N HCl and 0.025 N H<sub>2</sub>SO<sub>4</sub> solutions in a 1:5 ratio (w/v). The mixture was then shaken using a mechanical shaker for 30 minutes and filtered using Whatman No. 1 filter paper. The extracts were used for analysis of cadmium, magnesium, manganese, iron, lead, copper and zinc by the use of the Atomic Absorption Spectrophotometer (AAS).

### 3.0 RESULTS AND DISCUSSION

The following section will offer and discuss the results obtained from the experiment conducted above as summarized in table 1.

Table 1: Mean concentration of heavy metals in soil samples and plant samples by using four sources of water (July 2017-September 2017)

	Conc. in Soil Samples	Mean Conc. In Plants grown using Wastewater	Mean Conc. In Plants grown using Well	Mean Conc. In Plants grown using Shallow Borehole Water	Mean Conc. In Plants grown using Tap Water
Cd <sup>2+</sup>	2.63 ± 0.10	2.95 ± 0.13	3.62 ± 0.11	3.60±0.13	2.09±0.12
Mn <sup>2+</sup>	3.58 ± 0.22	8.92 ± 0.19	9.38± 0.96	10.63±0.48	8.58±0.58
Fe <sup>3+</sup>	113.06 ± 1.88	224.59 ±14.59	259.42 ±17.58	221.31±10.92	170.69±8.18
Zn <sup>2+</sup>	19.01± 0.09	32.31 ±0.79	26.41 ± 1.74	37.17±3.70	30.06±1.42
Mg <sup>2+</sup>	113.40 ± 1.22	114.30 ±10.87	170.87± 8.37	151.16±5.72	119.84±24.53
Pb <sup>2+</sup>	3.77 ± 0.10	7.78 ±0.7	7.65 ± 0.31	8.49 ±0.35	4.36±0.40
Cu <sup>2+</sup>	1.99 ± 0.12	4.77 ±0.29	4.08± 0.25	4.05 ±0.28	3.98±0.20

As indicated on table 1, it is clear that the soils along the study area exceed the tolerance limit values as recommended by the World Health Organization, thus acting as the main source of contamination in the edible leafy parts of the African nightshade grown along the river. The level of Cd<sup>2+</sup> and Pb<sup>2+</sup> in the soils which were 2.63 ± 0.10 and 3.77 ± 0.10 ppm respectively were above the World Health Organization acceptable limits. The WHO limit for Cd<sup>2+</sup> and Pb<sup>2+</sup> are < 0.1 ppm and < 2.00 ppm respectively in soils. Therefore, the continuous irrigation of the farms around the study area has resulted to the high

accumulation of the lead and cadmium in the soils.

For the crop samples that were irrigated using wastewater, a high level of  $\text{Fe}^{3+}$  was recorded  $224.59 \pm 14.59$  ppm though not above the WHO limits.  $\text{Cd}^{2+}$  and  $\text{Pb}^{2+}$  were  $2.95 \pm 0.13$  and  $4.77 \pm 0.29$  ppm which was above the standards. The soil-to-crop transfer factor for  $\text{Cd}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Pb}^{2+}$  AND  $\text{Cu}^{2+}$  WAS 1.12, 2.49, 1.99, 1.70, 1.01, 2.06 AND 2.40 RESPECTIVELY. THIS IS AN INDICATION THAT THE MOBILITY OF  $\text{Mg}^{2+}$  AND  $\text{Cd}^{2+}$  WHICH HAD A TF VALUE OF 1.12 AND 1.01 DID NOT INFLUENCE THE GROWTH OF *S. SCABRUM*.

FOR CROP SAMPLES GROWN USING WATER FROM THE SHALLOW WELLS, A HIGHEST VALUE OF  $\text{Mg}^{2+}$  AND  $\text{Cd}^{2+}$  WAS RECORDED AT  $170.87 \pm 8.37$  and  $3.62 \pm 0.11$  ppm respectively was recorded as compared to the other treatments. The TF values for  $\text{Cd}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Pb}^{2+}$  AND  $\text{Cu}^{2+}$  FROM THIS TREATMENT WERE 1.56, 2.50, 2.35, 1.73, 1.52, 1.50 and 1.84. This is an indication that CROP SAMPLES GROWN USING WATER FROM THE SHALLOW WELLS ARE influenced by the all the elements that were measured, thus all had TF value of  $>1$ .

FOR CROP SAMPLES GROWN USING WATER FROM THE BOREHOLE, THE HIGHEST VALUE OF  $\text{Zn}^{2+}$  AND  $\text{Mg}^{2+}$  WAS RECORDED AT  $37.17 \pm 3.70$  and  $8.49 \pm 0.35$  ppm respectively in comparison to the other treatments. The TF value for  $\text{Cd}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Pb}^{2+}$  AND  $\text{Cu}^{2+}$  was 1.55, 2.78, 0.99, 1.97, 1.29, 2.32 and 1.84 respectively. This is an indication that crops grow using water from borehole has the ability to exclude the uptake of  $\text{Fe}^{3+}$  SINCE THE TF VALUE WAS  $< 1$ .

For crops samples grown using tap water, the lowest values of  $\text{Cd}^{2+}$ , AND  $\text{Pb}^{2+}$  was recorded at  $2.09 \pm 0.12$  and  $3.98 \pm 0.20$  ppm as compared to the other treatments. This is an indication that tap water has the ability to lower the mobility of these harmful elements from the soil to the plants. This can be affirmed by the fact that the TF values of  $\text{Cd}^{2+}$ , AND  $\text{Pb}^{2+}$  were  $< 1$  at 0.95 and 0.97 respectively.

From the above, it is clear that in all the treatments, the level of cadmium in the crop samples ranges from 2.20 to 2.60 ppm which is above the tolerance limit of <0.1 ppm. Similarly, for lead, the value ranges from 3.50 to 5.00 ppm where as the WHO tolerance limit is < 2.00 ppm. For copper, magnesium and manganese, zinc and iron, the concentration in the soil was within the allowed limits, thus low chances of bioaccumulation.

#### **4.0 CONCLUSION**

From the results, it is notable that the value of  $Cd^{2+}$ , AND  $Pb^{2+}$  from crop and soil samples from all the treatments were above the required limits by the WHO. For crop samples grown using tap water, the concentration of  $Cd^{2+}$   $Pb^{2+}$  AND  $Cu^{2+}$  were lowest as compared to all the other treatments. This is an indication that the uptake of these toxic elements from the soil were reduced thus a lower level of sequestration in the edible parts of *S. Scabrum*.

#### **5.0 RECOMMEDATION**

Based on the results, it is clear that high level of  $Pb^{2+}$  and  $Cd^{2+}$  concentration in the soils resulted to high accumulation of these elements in the edible parts of *S.Scabrum*. Consequently, policy makers should educate the farmers on the need to carry out phytoremediation as one of the innovative risk-reduction interventions measures in regard to bioaccumulation. This is based on the fact that unlike other methods of reducing toxicity in the soils, phytoremediation is relatively affordable and effective hence can be quickly adopted by the farmers.

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# **Investing in Agricultural Leadership for Sustainable Food Security Planning in Kenya: Historical Insights from *Josephonomics***

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## **ABSTRACT**

Food insecurity and its indignity is still a persistent challenge in Kenya more than 50 years after independence. This opinion paper opines that despite the country's status of water scarcity with only about 30% of land being arable; Kenya can be food secure by tapping into already proven technological innovations within and without. What is lacking or deficient is people-centred agricultural leadership that can tap into available and practical innovations without having to re-invent the wheel. Leadership in this context means ability to inspire people to deliver on their competences under their unique circumstances. This paper explores this dimension through lessons directly and indirectly derived from *Josephonomics*. This philosophy is based on how legendary Joseph saved ancient Egypt from starvation. It is hoped that the lessons discussed can be utilised at both National and County government levels to create agricultural food belts and food stocks that would eliminate food insecurity and its impacts on households at much less budgetary implications.

**Keywords:** Food Insecurity, Practical Innovations, Agricultural Leadership, Kenya

## **1. Introduction**

The importance of food security, self-sufficiency and sovereignty in human and national development cannot be overemphasised (<http://www.globalagriculture.org/report-topics/food-sovereignty.html>). Inherent in food sovereignty is the right of peoples to healthy and culturally appropriate *food* produced through ecologically sound and sustainable methods, and their right to define their own *food* and agriculture systems. Nations have therefore an obligation to ensure that this right is met. According to Kenya's constitution, article 43 (1) (c) every person has the right to be free from hunger, and to

have adequate food of acceptable quality (Republic of Kenya, 2010). Investing in food sovereignty based on basic and yet practical measures at the grassroots should be revisited without neglecting high tech-agriculture that seems to be more appropriate for resource-rich commercial producers. Food as a provisional ecosystem service is very critical in augmenting the human well-being component of having materially enough for a decent life (Millennium Ecosystem Assessment 2003). Sustainable Development Goal Number 2 focusses on ending hunger, achieving food security and improving nutrition and promoting sustainable agriculture (<https://sustainabledevelopment.un.org/>).

Unfortunately, the indignity of starvation and famine continues to be experienced in various parts of the world, and in particular Africa. Currently drought-driven famine is ravaging Somalia. According to the World Food Program 3.2 million people are currently at risk. Some 350,000 children are malnourished, including 70,000 severely malnourished (<https://www.voanews.com/a/famine-in-somalia-averted-for-now/3908196.html>). Kenya too continues to incur political and social costs of inadequate food stocks. The debate on maize scarcity during the presidential election of 8<sup>th</sup> August 2017 attests to this. Although the building blocks of food production are availability of adequate arable land and good climate (rainfall and temperature), human and social capital have a major role to play in the quest for food security, sovereignty and self-reliance. Other factors that influence spatial intra and inter-generation food security are illustrated in the conceptual framework in figure 1 below. Their relative importance is expected to vary across nations.

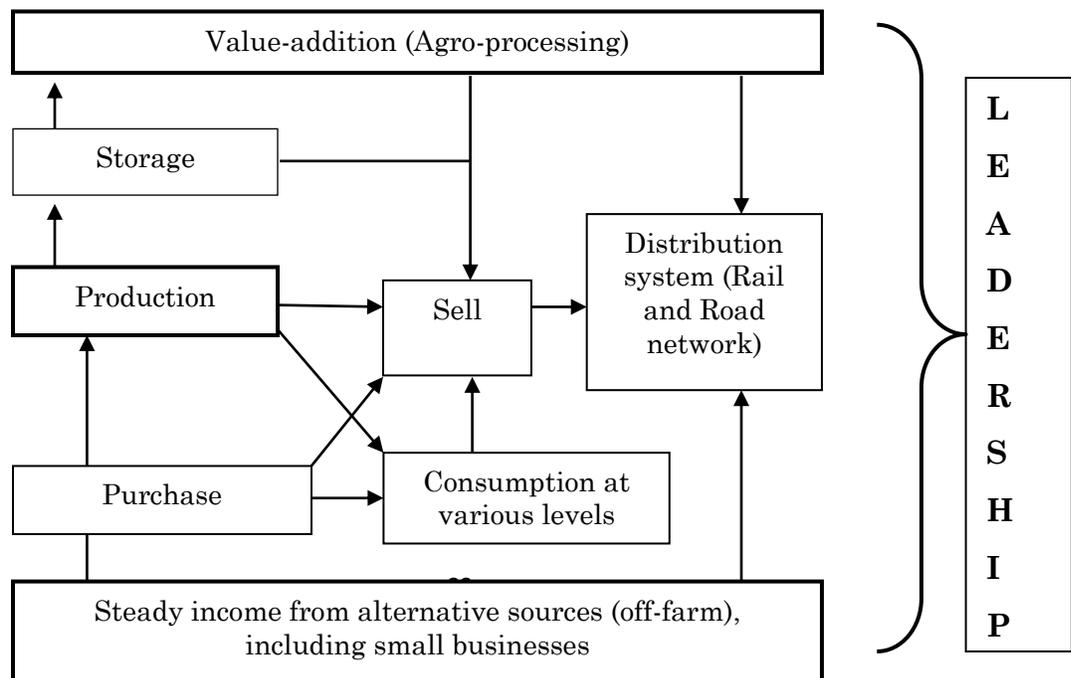


Figure 1. Modified from: Waswa *et al.*, 2014

Self-sufficiency in food is hinged upon production of adequate quantities of quality food within a nation's borders. Often times this fails to work due to a myriad of limitations particularly scarcity of land and other crop husbandry challenges. To counter this challenge, food imports and food aid become necessary interventions, their negative impacts on recipient nations notwithstanding. Where food security is undermined by food wastage, value-addition through various forms of agro-processing has proved very valuable. Mbeine (2014) quoting a world bank report noted that the value of Uganda's value added products in 2011 stood at \$3,870,911,000.00, Tanzania's stood at \$5,780,320,210, while Kenya had the highest agricultural value added, which stood at \$8,346,408,890.00

The potential of value-addition in Kenya is huge especially in regions where surplus food goes to waste due to lack of processing and physical infrastructure that are critical in value-addition and food marketing. Storage losses too are known to significantly undermine food self-sufficiency and security. For resource-poor farmers in semi-arid areas where annual rain-fed agricultural cannot be guaranteed, investment in off-farm livelihood initiatives and off-farm income sources has safe-guarded human well-being. With a steady flow of income households can purchase food rather than rely on production (Waswa, 2014). Sustainable consumption too has the advantage of reducing food wastage and hence pressure on production. Ultimately all these interventions require the appropriate socio-economic and political environment, hence visionary political and agricultural leadership.

This opinion paper interrogates the apparent unending challenge of food insecurity in Kenya more than 50 years since independence. The hypothesis is made that persistent food insecurity is caused more by poor agricultural leadership (administrative and

managerial) than shortages in human, social, natural, financial and physical capital. By virtue of its many training programmes in agriculture (Commission for University Education, 2016) Kenya rolls out qualified agricultural scientists, policy makers and technocrats, but their contribution to the food security agenda appears to be only miniature. In addition the country has more than enough land (arable and semi-arid) to raise crop and animal products (UNEP, 2009), yet food insecurity in most parts of the country remain a pressing challenge. Attempts to transform this vast territory into agricultural belts though experiencing some challenges are currently exemplified by the Galana Gulana irrigation scheme (National Irrigation Board, 2017). While scarcity of water can be a real challenge, Israel at number 24 on the list of most food secure countries in the world is among the countries that have succeeded to feed their people under water stressed and water scarcity conditions. In Africa, only South Africa at number 46 appears on the world's 50 most food secure countries in 2017 (The Economist Intelligence Unit, 2017). Rather than re-inventing the wheel, food insecure countries can learn from these countries and implement similar strategies at much reduced costs. Accordingly blaming food insecurity and its indignity on unreliable and erratic rainfall when success stories about nations experiencing similar natural constraints exist undermines the creativity, innovation and research excellence inherent in human beings.

## **2. Methodology**

This paper has relied on secondary data and in particular historical lessons denoted *Josephonomics*. If legendary Joseph was able to save ancient Egypt from starvation, it is possible that with good political and agricultural leadership, Africa and in particular Kenya can also be food secure in the same context as defined by FAO, i.e. the condition in which all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (<http://www.ifpri.org/topic/food-security>). Without minimizing the role of technology, this paper seeks to challenge policy makers to focus more on managerial/leadership innovations based directly and indirectly on *Josephonomics* in pursuit of food security at both County and National levels in Kenya.

### 3. Results and Discussion

#### *3.1 Empowering the Vision Carrier to Lead*

From a historical perspective, the Bible documents a story of the *Pharaoh* having had dreams that disturbed him and wanted them interpreted. “*And Pharaoh said to Joseph, “In my dream, behold, I stood upon the bank of the river (Nile) and, behold, there came up out of the river seven cows fat and sleek, and they grazed among the reeds. After them, seven other cows came up – scrawny, very ugly and lean. I had never seen such ugly cows in all the land of Egypt. The lean, ugly cows ate up the seven fat cows that came up first. But even after they ate them, no one could tell that they had done so. They looked just as ugly as before. Then I woke up. In my dream I also saw seven heads of grain, full and good, growing on a single stalk. After them, seven other heads sprouted – withered and thin and scorched by the east wind. Then the thin heads of grain swallowed up the seven good heads. I told this to the magicians; but there was none that could declare it to me”*(Genesis 41:17-25).”

Per advantage, there was in Egypt a Hebrew slave and prisoner called Joseph who could interpret dreams. Joseph made it known to the Pharaoh that after 7 years of bumper harvest; Egypt would be hit by another 7 years of severe drought and famine. The nation needed to take advantage of the initial seven years of abundance and plan effectively for the next seven years of drought and scarcity, thus:

*Now therefore let Pharaoh look out a man discreet and wise, and set him over the land of Egypt. Let Pharaoh do this, and let him appoint officers over the land, and take up the fifth part of the land of Egypt in the seven plenteous years. And let them gather all the food of those good years that come, and lay up corn under the hand of Pharaoh, and let them keep food in the cities. And that food shall be for store to the land against the seven years of famine, which shall be in the land of Egypt ; that the land perish not through the famine*(Genesis 41:33-36). Unlike most government technocrats and politicians, who tend to take the path of political correctness in such sensitive matters, Joseph gave the pharaoh sound advice and a blue print on how to manage the looming drought-driven food insecurity.

Having interpreted the dream to the King's satisfaction and against all odds, the Pharaoh entrusted and empowered Joseph with the entire food security planning responsibility to save Egypt from looming disaster. Here-in is the first principle of good political leadership that empowers the vision carrier to build and lead a problem solving team. As a lesson governments where food insecurity is a persistent challenge should audit their personnel and check out the capacities and competences of persons responsible for food security planning and policy implementation. The proceeding section of this paper examines other specific strategies Joseph employed directly or indirectly and how they too can work for Kenya and other nations having similar challenges today.

### ***3.2. Qualifications of other Decision makers in Agricultural Development***

Having been entrusted with the entire responsibility of food security planning, it is very likely that legendary Joseph too identified and deployed persons with relevant capacities and competences at various stages of the food security strategic plan. This principle can also apply along the crop or animal product value chain in any nation. In this context, it would be appropriate to audit the entire agricultural sector, including line ministries and support agencies with view of enhancing labour specialization and job evaluation. Such an audit is likely to eliminate resource wasting duplication of roles and enhance resource use efficiency and agricultural productivity. When it comes to job evaluation, the nation has in place the Salaries and Remuneration Commission (SRC) which is tasked with among others such a responsibility (SRC, 2015).

### ***3.3. Weather Forecasting and Early Warning Systems***

Prediction of a seven year period when conditions for agriculture would be ideal (enough and regular rainfall) and another of 7 years of severe drought can be equated to intuitive weather forecasting. Today meteorological science has adequate technology that can fairly track weather changes and together with the extension service inform, educate and advise farmers when to till and plant their crops. For Kenya, the challenge is to invest more in increasing accuracy in predicting hydrological events, and in particular provision of meteorological and climatological services to agriculture for the better exploitation and

utilization of natural resources for national development as envisaged by the Kenya Meteorological Department (2015). Often times prediction of rainfall seasons have been inaccurate in the past resulting into poor planning by farmers and hence failure to meet agricultural objectives.

### ***3.4. Maximising Production when conditions are favourable***

When natural conditions are favourable, every effort needs to be made to maximise on production of a variety of foods with emphasis on non-perishables (cereals and pulses). Putting as much land as possible into crop and animal production should be priority. According to Feller (2015), only about 8 per cent of the total arable land available in Kenya is under cultivation. If Kenya expects to feed its own exploding population in future and also earn export revenue from agriculture, it is clear that much more arable land needs to be put into farming. Unfortunately much prime land remains idle and is locked up as institutional land, agency lands, ministry land, wetlands, riparian land, national parks, game reserves and private land – all protected as such by the prevailing land tenure systems. Of these categories of land, public land remains at high risk of grabbing and land use change to non-agricultural purposes (Southall, 2005).

Leadership that is disturbed by the indignity of food insecurity and its impacts on the populace can make deliberate effort to transform such land and particularly land under the management of Kenya Agricultural and Livestock Research Organisation (KARLO), National Development Corporation and the vast ASAL areas under community land tenure into “National Green Belts” (NGB) to grow food, without losing the prevailing tenure status. Leasing public land to able agricultural entrepreneurs and supporting them with seed capital to initiate farming would in addition to increasing food availability, also create employment to many youth who are graduating from Universities and cannot find white colour jobs. The law should demand that all idle private land in each of the 47 Counties in Kenya be put to use or the owners be fined sums equivalent to what such farms could optimally produce per year.

### ***3.5. Increasing Water availability for Irrigation Agriculture***

While Joseph relied on rain-fed agriculture and perhaps traditional surface irrigation, Kenya being a water scarcity nation (UNEP, 2002) can tap into alternative water sources using available technology for enhanced farming in drylands. The Water Act of 2016 vests every water resource the State, subject to any rights of user granted by or under this Act or any other written law (Republic of Kenya, 2016). Moraa *et al.* (2012) observed that a range of technical solutions for water problems could work if governance structures in Kenya are good. Water governance in this context entails upholding of the policies, strategies and legislation where water service providers have to develop and manage water resources in an efficient and effective manner while being accountable to the recipients of the services.

Despite the effects of climate change, Kenya still has several perennial rivers which empty their precious fresh water into the Indian Ocean or Lake Victoria. Construction of a series of dams and reservoirs to harvest excess water during the rainy season would ease life during the drought seasons. Water from rivers Tana and Athi in particular can be used to transform much of the semi-arid part of Kenya into agricultural belts. With 17% of the land considered to have medium to high *potential* for *irrigation*, less than 10% is utilized, which amounts to only about 2% of total arable land in *Kenya* (You *et al.*, 2014). According to Kenya's vision 2030, the ASAL development irrigation projects aims to increase the area of ASAL land under irrigation to about 1 million hectares (Republic of Kenya, 2007). That the Israel-driven *Galana Kulalu* irrigation scheme has been attempted with little success is indicative of the impacts of poor agricultural governance and not lack of technology and human capital. As far as harnessing Lake Victoria water for irrigation agriculture in the food insecure Nyanza region is concerned, the historical River Nile treaty that appears to have granted Egypt significant advantage against the riparian countries (Kimenyi and Mbaku, 2015) should be expeditiously concluded based on mutual gains approach to negotiations.

As each of the 47 County headquarters continues urbanising, the potential for reclaiming domestic sewage for peri-urban irrigation agriculture should not escape the eyes of planners. County governments should deliberately plan their sewage plants to

accommodate tertiary purification as has been demonstrated elsewhere in the world. For instance treated sewage water provides close to a quarter of Israel's demand for water (Harris, 2015).

The potential for desalinating huge amounts of ocean water to support agricultural development in the Coast region should equally remain in focus. A limiting factor globally, which is the focus of research remains the cost involved. According to By Bienkowski (2015), it takes most reverse osmosis plants about 3-10 kilowatt-hours of energy to produce one cubic meter of freshwater from seawater. Traditional drinking water treatment plants typically use well under 1 kWh per cubic meter. At the appropriate time, Kenya could take advantage of this technology.

### ***3.6 Strategic Storage and Food Saving Culture***

Sustainable consumption patterns cannot be divorced from eating a determined portion of the harvest and storing another portion for lean times. The quantities to be stored can be worked out along the same principles of financial household budgeting. *Josephonomics* settled on a 5<sup>th</sup> of the harvest for storage (Genesis 41:34-35 – New International Version). A part from storage at the household, Joseph emphasised the need for government managed decentralised food storage facilities. In Kenya County government would complement the National Cereals and Produce Board (NCPB) by creating County Cereals and Produce Boards (CCPBs) to manage food storage in the 47 Counties in the country. The concept of eating and saving a portion should also be inculcated at the household levels and mainstreamed in primary schooling in order to develop a generation that gets offended when food is wasted along the crop value chain and in particular at the dining table.

### ***3.7. Value-addition and Elimination of Food Wastage***

*Josephonomics* is silent on this aspect. However, according to FAO, roughly one third of the food produced in the world for human consumption every year gets lost or wasted. Further, in developing countries food waste and losses occur mainly at early stages of the food value chain (i.e. during food production). About 40% of losses occur at post-harvest

and processing levels while in industrialized countries more than 40% of losses happen at retail and consumer levels. This inevitably means that huge amounts of the resources used in food production are used in vain (<http://www.fao.org/save-food/resources/keyfindings/en/>). To avoid food waste at both the farm and kitchen levels, farmers need to invest in value-addition to preserve the food and increase the shelf-life. According to Koigi (2015), Kenyan farmers seem to have made good progress in this area. However more gains can be achieved by making value-addition infrastructure readily affordable and accessible to farmers.

### ***3.8. Mitigating and Coping with Drought Events***

When the 7 years of plenty ended and the 7 years of drought started, households in ancient Egypt reverted to their storages. Upon exhausting these home-based reserves, citizens accessed government-managed reserves at a cost and not as relief food (Genesis 41:55-57). As a principle, where people have no money to buy food, a work for food policy can be invoked. Relief food should not be an option as it encourages dependency syndrome. Monitoring food stocks and rationing in moments of drought should be the norm and not the exception. Since drought significantly restricts rain-fed agriculture, farmers should have the attitude of making strategic shifts to off-the farm livelihood strategies as need may arise. In this context, investment in apiculture and small to medium scale agri-businesses remain particularly potent. A part from guaranteeing farmers regular income, apiculture reduces pressure on land and does not require much family labour. Agricultural leadership should consider providing requisite incentives for farmers to invest and maximise on hive products in much of the semi-arid lands of Kenya.

### ***3.9. Food Marketing and Imports***

While *Josephonomics* may not have explored the dimension of food exports and imports, it is common in Kenya for resource poor farmers to sell their crop products at throw-away process to brokers, only to re-buy the same food (now as dried maize) at exorbitant prices. While this behaviour of distress sales is expected in free market capitalistic systems, good leadership should step in to protect and cushion such vulnerable farmers.

Some policy initiatives can be put in place to regulate the popular distress sale of food, particularly maize, bananas, sweet potatoes, pulses, onions and tomatoes from the maize belt and Meru region. Through farmers associations, prices and quantities to be sold can be fixed by farmers themselves and enforcement guaranteed through County government measures. This way brokers that often take advantage of such financially-marginalised farmers will be deterred. Where agricultural leadership in a country is progressive, food imports should be diminishing with time in favour of exports with added value. Although food security encompasses production and or purchases from elsewhere, importation of maize, sugar, wheat, rice, eggs and chicken into Kenya communicates existence of serious gaps in local production policies. Unless inevitable, importation should be restricted to what is not grown locally in order to ensure value for money. Spatial agricultural suitability for Kenya is sufficiently described in various handbooks that are available to planners (Jaetzold, *et al.*, 2005).

### ***3.10. Poverty-enhancing Cash Crops***

Debate needs to be initiated on whether food security or export cash crops including cut flowers should take up much of the country's prime land and fresh water resources. For instance, sugarcane in particular is directly associated with poverty in Western Kenya (Waswa *et al.*, 2009). After realising that returns from coffee are not meeting their needs, some farmers in coffee zones have also diversified from this once essential crop (Kanyiri and Waswa, 2017). But even more tragic, much prime land once under coffee is now being converted into real estate in the peri-urban areas of Nairobi like Kiambu County. Research can also establish whether Tea and Sisal are poverty enhancing crops in Kericho and Taita respectively. Similarly though a staple food crop, circumstances under which maize is a poverty trap in Uasin Gishu County needs attention. For the sake of future generations, County governments need to protect and preserve their prime land for food production. This calls for progressive land use policies that restrict urbanisation to marginal land.

### ***3.11. Transport Networks to link farmers to Markets***

A nation may not be described as food secure when people in one part of it have excess

food rotting on their farms, while others in another part are starving. Such scenarios are common in Kenya and are often caused by lack of or poor road networks that prevent food from getting to various markets. Investing in feeder roads and easing transportation guidelines is critical in food security planning. With visionary leadership in the newly established Kenya Highways Authority and the Rural Roads Authority, the future can only be positive. Having successfully commissioned the Standard Rail Gauge transport infrastructure, the focus should shift to investing into feeder roads to link farmers to markets. This should be manageable on the part of government.

#### **4. Conclusions and Recommendations**

As has been said, there is really nothing new under the sun. What is has been and shall be again in future. History thus has many lessons that could help current generations avoid mistakes that can be very expensive. By maximising on managerial innovation legendary Joseph implemented a strategy that saved ancient Egypt and the entire known world then from a catastrophic drought-driven famine. Today with the advantage of advanced technology, no nation should suffer the impacts of food insecurity. What can be done and how to do it already exists. Therefore re-inventing the wheel through massive investment in high-tech agricultural research should now be viewed as secondary to providing the leadership needed to implement existing, simple and practical measures of being food secure. Leadership in this context should be understood to mean visionary decision-making that inspires people at various stages of a product value-chain to spontaneously perform their duties in pursuit of a shared vision – in this context achieving food security for Kenya.

Priority indicator for such leadership would be having and empowering the right professionals at the right placements in the agricultural value chain. An audit of personnel would weed out workers who are more of liabilities than assets to the sector.

There is need to put every idle yet productive land under appropriate agriculture without offending the prevailing tenure systems. Kenya has vast quantities of such land. The national and county governments need to work with the national land commission to

rebrand such prime idle land as national or county green belts for food production. The required labour is available in the many unemployed agricultural and entrepreneurial graduates. These youth could be supported with seed capital upon qualifying based on vetted agri-business plans.

In terms of water availability, each of the 47 County headquarters should invest into domestic sewage plants that culminate at tertiary purification as has been demonstrated elsewhere in the world and the treated water harnessed for urban and peri-urban irrigation agriculture. As global research attempts to reduce the costs of desalination, harnessing the huge amounts of ocean water should not escape the eyes of policy formulation in future agricultural governance.

Most importantly, every effort should be made to maximise production when natural conditions are favourable. Food waste too needs to be aggressively prevented through strategic and devolved food saving and storage mechanisms including investment in value-addition especially at the post-harvest stage. These proven measures call more for re-invigorating agricultural leadership at both national, county and farm levels than investing in totally new technical research.

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# **Sub-Theme: Transformative Development through Language, Culture and Communication Technology**

**A complexity of Kiswahili Pairwise of Verbal Extensions: Algorithmic approach**

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## **ABSTRACT**

The paper describes semantics architecture of morph pairwise in Kiswahili verbal extensions. Kiswahili morphology is well documented, though semantic descriptions of these morphs are ignored and the theory for handling them. For instance some verb morphs are silent semantically though morphologically exhibit i:e the verb wa-sh-i-k-a ‘burnable’ in Swahili language is difficult to explain the sense and its constituents, and most of the speakers and writers generalize such verbalizers senses and ignoring each constituent’s sense such behavior needs to be described at length and the way of handling them theoretically. Cognitive Grammar was the theory applied for data analysis. The theory describes that meaning can be figured out basing on not only by word constituencies but context and experiences of the language users. The technique for data collection was documentary reviews of which 5 sources were reviewed to see how such derivations have been generalized semantically against algorithm architecture then depicting the generalized data for more algorithm analysis. It was found that, a step by stem derivations may make us understand the silent semantics of verbal morphs and their implicit senses other than generalizing them. Thus since Kiswahili is becoming a global language and East African in specific, its grammar should be well identified.

**Keywords:** Kiswahili, verbal extensions, pairwise, algorithm, semantic architecture

## Introduction

This paper aims at describing of morphological algorithm of Kiswahili pairwise of verbal extensions in the scope of semantics. Kiswahili language has been well documented in term of verbal extensions (Doke, 1943; Ashton, 1944 and Khamis, 2008), though in terms of semantic variability there are areas in research which need to be well clarified in this language, and this is nothing but semantic algorithm of some derivations.

Literatures have been documented in pertinent to Swahili Verbal Extensions as in Khamis (2008, Kihole, 2008, Lothi, 2002, Mdee *eta al*, 2013 have discussed a lot in pertinent to Kiswahili Verbal morphs' pairwise though they did not adhere to semantic step by step algorithm<sup>1</sup>. The data in 1 below illustrates the phenomena<sup>2</sup>:

- |    |                          |                       |
|----|--------------------------|-----------------------|
| 1. | a)                       | <i>Sumbu-a</i>        |
|    | Annoy-FV                 |                       |
|    | ‘Annoy’                  |                       |
|    | b)                       | <i>Sumbu-k-a</i>      |
|    | Annoy-STAT-FV            |                       |
|    | ‘Annoy able/disturbed’   |                       |
|    | c)                       | <i>Sumbu-k-i-a</i>    |
|    | Disturb-STAT-APPL-FV     |                       |
|    | ‘Annoy for/to’           |                       |
|    | d)                       | <i>Sumbu-k-i-an-a</i> |
|    | Disturb-STAT-APPL-REC-FV |                       |
|    | ‘Annoy for each other’   | (Khamis, 2008:172)    |

The data in 1a) has no derivation, whereby in 1b) there is derived stative morph *-k-*

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<sup>1</sup>The term *algorithm* is used in this paper unlike the way it is applied computationally, here it is used mechanically being it each morph reflects its own semantics hence morpho-semantics

<sup>2</sup>The following are abbreviations used in this paper:

STAT= Stative

FV = Final Vowel

PASS= Passive

CAUS= Causative

Cf = cross reference

APPL- Applicative

SP =Subject Prefix agreement

P = Preposition

TNS =Tense

which is known as a valence decreasing argument in Bantu. In 1c) we observe the ordering of two morphs: stative *-k-* and applicative *-i-*. In 10d), three morphs are being ordered in a single root, these are stative, applicative and reciprocal. The ordering of the two morphs (cf, 1c) and three morphs (cf, 1d) indicate contextually that, most of Swahili speakers inhibit the semantic content of stative morph, that is why the semantic realm does not exhibit stative logical form (LF) as it is shown above. However, I peel to saying, this area of exhibition morphs in pertinent to their semantic content has not been taken into account despite the claim that Kiswahili has been much documented.

The pairwise of applicative *-li-* and passive *-w-* from the verb *sumbu* ‘annoy’ brings another tantamount claim in relation to semantic interpretations. This means that the two morphs do not explicitly show their sense and even the native speakers themselves generalize their semantic content. The data in 2 below illustrates the phenomena:

- |    |                         |                     |
|----|-------------------------|---------------------|
| 1. | a)                      | <i>Sumbu-a</i>      |
|    | Annoy-FV                |                     |
|    | ‘Annoy’                 |                     |
|    | b)                      | <i>Sumbu-li-a</i>   |
|    | Annoy-APPL-FV           |                     |
|    | ‘Annoy for/with’        |                     |
|    | c)                      | <i>Sumbu-li-w-a</i> |
|    | Annoy-APPL-PASS-FV      |                     |
|    | ‘Be annoyed (for/with)’ |                     |

The data in 2b) shows that applicative morph *-li-* is ordered together with passive morph *-w-* but each sub categorization frame’s sense does not account its semantic independences. When Swahili speakers are in conversation (consider 2c) the first sense in their schema is passive and not applicative. This can be justified from 3 Swahili structure below:

- |    |   |          |           |                     |           |              |
|----|---|----------|-----------|---------------------|-----------|--------------|
| 3. | <i>Juma</i>                             | <i>a</i> | <i>me</i> | <i>sumbu-li-w-a</i> | <i>na</i> | <i>Mwizi</i> |
|    | Juma-SP-TNS-annoy-APPL-PASS-FV-P.2thief |          |           |                     |           |              |
|    | Juma has been annoyed (by the thief)    |          |           |                     |           |              |

Taking the meaning (cf 2b) of applicative morph when alone, it is confusing the fact that the sense of applicative when ordered together with passive is reduced, it shows as if such

morph is latent or is not activated by speakers of the language. The data in 3 shows applicative sense is reduced or inactivated. However, new approach of Swahili pairwise analysis is required to contributing to linguistics theoretical morphology. The step by step analysis is important in the sense that each morph may be understood it's either morphological or semantic content in any word formation process.

This behavior of opacity is displayed to other Bantu languages including Kisukuma, (Chípanda, 2017 and Citumnuka, Chavula, 2016). Kisukuma is the language spoken in North western part in the United Republic of Tanzania and Citumbuka is the language spoken in Northern region of Malawi and also in the Lundazi district of Zambia. The data in Citumbuka illustrates semantic opacity in 4 below:

4. *Timb-an-il-an-a*      *pa*  
Hit -REC-APPL-REC-field  
 ‘Hit each other at the farm/crop field.’ (Chavula, 2016:208)

The data in (4) shows that there are three ordered morphs together namely: reciprocal, applicative and reciprocal. The semantics of the sentence does not reflect the sum of its parts as it is in other lexical words. Therefore, a fully description is needed to capture this behavior and that new theoretical paradigm is needed to explain such kind of semantic scope of each morph where applicable other than generalization from the written literature. As Corbin and Strauss (2008:21) who are of the opinion that the problem can be drawn from non & technical literatures.

Therefore, the current study in pertinent to Kiswahili complexity verbal extension pairwise will shed light to understanding explicitly the important of semantic algorithm – which is a step by step technique of analyzing linguistics sub categorization frames.

Mdee *et al*, (2013) have shown the data from Kiswahili dictionary of twenty one century, the derivation of the verb *iga* which means ‘imitate’ ignores the ordering of applicative passive pairwise as if is ungrammatical or absent in its lexicon. The data in 5 below illustrates the phenomenon:

5. *Ig-iw-a*  
Imitate-FV  
‘Be imitated’

The data in (5) shows that the passive morph *-iw-* has been attached to the verb *iga*

which means imitate and form *igiwa* imitated. Under the level of analysis most of Swahili speakers and writers have been generalizing the phenomenon. Since the diction has an applicative *-i-* attached to the verb entry *iga* as it is indicated below:

6. *Ig-i-a*

Imitate-APPL-FV

‘imitated for/with’ (Mdee *et al*, 2013:150)

Therefore it is not appealing to have the derived verb *Igiwa* (*cf*, 5) and claim to have only one morph which is nothing but other than two morphs as in applicative *-i-* and passive *-w-*, as 7 data illustrates:

7. *Ig* *-i* *-w* *-a*

Imitate-APPL-PASS-FV

‘Be imitated (for/with)’

The data in (7) shows that two morphs namely: applicative and passive have been ordered together simultaneously in a single verb *Iga*, and each morph has its own semantics despite the generalization of meaning which has been operationalized by Swahili writers and the speakers as it has been shown elsewhere (*cf*, 5) in this paper.

However, the literatures and the data available (*cf* 7) shows that there is a less/incomplete knowledge in Swahili pairwise of verbal extension other than generalization. As Booth, (2003:59) argues, ‘research problem is motivated not by palpable unhappiness but incomplete knowledge or flawed understanding, thus we can solve it not by changing the world but by understanding it’. Therefore, such incompleteness of the knowledge in Swahili data above needs re-analysis.

### ***Methods of data collection***

The technique used in data collection was documentary review, 4 Swahili books including Swahili dictionary of 21<sup>th</sup> century were purposively selected and reviewed. These sources were read one by one basing on the topicalized morphs under discussion to see how Swahili data are being treated Vs their semantic scopes. Content analysis was used during data analysis; the data were analyzed verb morph by verb morph and assigning each morph’s semantics basing on the study objective.



- ‘Stop for’
- b) *Ach* *-i-an-a*
- Stop-APPL-REC-FV
- ‘Stop for each other’
- c) *Ach* *-i* *-an* *-i* *-a*
- Stop-APPL-REC-APPL-FV
- ‘Stop for each other for/with’

The data in 9 a), b) and c) shows that each morph has its own semantics, in other words for instance, step three of 19c) shows that there are three individuals following the fact that, the two applicative allomorphs represent two arguments. The sentence in 10 below gives more detail explanations:

10. a) *Juma* *a-me* *mw-ach* *-i-a* *mtoto*
- Juma-SP-TNS-OB-quit-APPL-FV
- ‘Juma has quitted for the child’
- b) *Juma* *na* *Masanja* *wa-me* *ach* *-i-an-a* *mtoto*
- Juma-C-Masanja-SP-TNS-quit-APPL-AREC-FV-child
- ‘Juma and Masanja have quitted each other for the child’
- c) *Juma* *na* *Masanja* *wa-me* *ach* *-i-an-i-a* *mtoto*
- Juma-C-Masanja-SP-TNS-quit-APPLA-REC-APPL--FV-child
- ‘Juma and Masanja have quitted for each other for the child’

The sentence in 10a) shows that there are two arguments namely: the external argument *Juma* and the internal argument *Mtoto* ‘child’. Semantically, the external argument has done the action of quitting for the child. The sentence in 10b), there are also two participants following the fact that the addition of reciprocal morph (valence decreasing) reduces one case—the internal argument. Therefore, the meaning shows only the function of the external argument — being the subject and the internal argument being objective case in syntax. As a matter of facts, in 10c) there are three arguments the first two arguments are triggered by the first (applicative) and reciprocal morph while the third is triggered by the second applicative morph. This form of ordering in Bantu languages has been difficult to process as the result of linguistics generalization. The data in the table below shows how step by step derivations accounts for Swahili verbs ordering: *achiania*:

Table 1: The input word: *achiania*

Root	<i>	<ii>	<iii>	Features
<i>Ach-</i>	<i>-i-</i>			+v
		<i>-an-</i>		-v
			<i>-i-</i>	+v

The derivation in the above table shows that each step of derivation accounts both morphology and syntax in pertinent to the meaning of the derived element being it a morph. The sign of <+v> implies productive suffix or valence increasing argument and the <-v> implies non productive suffix or valence decreasing argument to the predicate structure. The number of arguments depends on the kind of suffixes being ordered to the verb. That is why (cf, <ii>) the derivation of the reciprocal *-an-* has the same number of arguments with the derivation (cf, <i>) of the applicative *-i-*. This is because the reciprocal is the valence decreasing and it reduces one argument in the predicate structure. The second applicative morph (cf, <iii>) has added the number of arguments up to three since it is the valence increasing as it is in the first step. It must be noted that the number of steps depends on the limit of the ordered morphs in the language under discussion, and that in Kiswahili, the maximum number of verbs morph ordering is four (see Kihore, *et al* , 2008) unless otherwise stated.

The other discussion can be drawn from the Swahili verb *waka* ‘burn’ whose stem is *wa-*, that is to say the stem *wa-* in pertinent to verb derivation is often used with stative *-k-* which is inactivated or latend morph, as in *wa-(ka)* ‘burnable/able to burn’. Moreover, as it may, if this is taken as it is (word verb) *waka* —its derivation ends to two steps as it is shown in 11 data below:

- 11.
- |                 |    |                 |
|-----------------|----|-----------------|
|                 | a) | <i>Wak-a</i>    |
| Burn            |    | (STAT)-FV       |
| ‘Burn/Burnable’ |    |                 |
| b)              |    | <i>Wak-i-a</i>  |
| Burn            |    | (STAT)-APPL-FV  |
| ‘Burn to/in’    |    |                 |
| c)              |    | <i>Wak-ik-a</i> |

- Burn (STAT)-STAT-FV  
 ‘Able to burn’
- d) *Wak-iw-a*
- Burn (STAT)-PASS-FV  
 ‘Be burnt’

The data in 11 shows that the Swahili word *waka* ‘burn’ is taken as a full word whose stative morph *-k-* is inactive in use. That is why the meaning being derived shows as if such stative does not work following the fact that the meaning is not the sum of its parts.

The blacked indicates that *-k-* is stative

However, when *wa-* is taken as the stem of the word *waka*—its derivation takes other form of ordering morphs e.g. causative morph in which other morphs like stative, passive, reciprocal appears far from the stem. It is from this account, a step by step analysis of the stem *wa-* is re-analyzed in the table below:

Table 2: The input stem: *wa-* (*sh-i-an-/-wa-/-ik-a*)

Root	<i>	<ii>	<iii>	Features
<b>wa-</b>	<i>-sh-</i>			<sup>+</sup> v(valence)
		<i>-i-</i>		<sup>-</sup> v(valence)
			<i>-w-/-k-/-an-</i>	<sup>-</sup> v(valence)

The stem *wa-* as we see in the above table, has been derived up to three morphs maximally. It must be noted that at step three, any of the listed morphs can be ordered from the stem alone and not simultaneously. See in 12 data below:

12. a) *Wa-sh-i-w-a*  
 Burn-CAUS-APPL-PASS-FV  
 ‘Be made to burn for’
- b) *Wa-sh-i-an-a*  
 Burn-CAUS-APPL-REC-FV  
 ‘Cause to burn each other’
- c) *Wa-sh-i-a*  
 Burn-CAUS-APPL-FV

‘Cause to burn for/in/to/with’

d)

*Wa-sh-i-k-a*

Burn-CAUS-APPL-STA-FV

‘Able to burn (make be able to burn for)’

The data in 12 evidenced that *wa-* is the stem of the word *waka* ‘burnable’ in Kiswahili language and its derivation can start soon after the stem. For that matter the morph *-k* from the stem *wa (ka)* is the stative morph and its semantic scope would be the ability of something to burn/be burnt. This is a complexity of Swahili pairwise of verb ordering because most of the Swahili speakers and writers do not consider such deepness understanding other than making generalization both morphologically and semantic scopes. This can be seen in 12d) data *washika* where the meaning of the derived verb is complex to process following the fact that stative has proceeded causative as the result causative reduces its conceptual power.

The ordering of causative allomorphs as in *-ez-* and *-esh-* also gives evidence on how Swahili verbs ordering of verbal extensions must be treated carefully. Although it is obvious for the causative being productive, in some contexts its productivity cannot be in all verbs of Kiswahili language. The data in 13 below illustrates the phenomenon of its complexity ordering:

13.

*Pend-ez-esh-a*

Love-

CAUS-CAUS-FV

‘Cause to appear good’

The data in 13 shows that the verb *penda* ‘love’ has been followed by two causative allomorphs, though the semantics of each morph is not derived. This means that, the speakers of Kiswahili language make generalization as it has been stated elsewhere. The causative *-ez-* acts as instrumental morph—it adds material condition which leads to good or something/somebody to appear well/smart and good physically. Consider the sentence in 14 below:

14.

*Juma*

*hu-pend-ez-a*

*Nguo*

Juma-ASP-love-CAUS-FV-Clothes

‘Juma appears good (because of clothes)’



Therefore, when a person says <*pigilia mpira*> ‘pass the ball’ does not refer to the addition of an argument other than referring to external and internal argument which is nothing but basic sentence structure. More explanations consider the following structure in 16 below:

17. *Kamsoko -ka-m-pig-i-li-a mpira Mavugo*  
 Kamsoko-TNS-OM-pass-APPL-APPL-FV-ball-Mavugo  
 ‘Kamsoko has passed the ball to Mavugo’

The data in 16 above indicate that, the applicative allomorphs do not specify their meaning each; the structure shows as if there is applicative *-ili-* following the semantics and syntax of it. In this data, I appeal to arguing that, since the contextual action sometimes dictates the meaning of allomorphs, *-ili-* applicative morph can be one morph with one argument in the predicate structure. The data in 18 below illustrates how the morph may work alone:

18.a) *Chom-e-a* Pierce,-APPL-FV  
 ‘Pierce for/to/with’  
 b) *Chom-e-le-a* Pierce,-APPL-APPL-FV  
 ‘Drilling iron?’

The morph *-e-* in 18a) is an applicative with multiple function, it may function to show instrument, location or argument. The data in 18b), shows the two morphs are being ordered together, as it is indicated above (cf, 17) the second applicative (cf, *-le-*) breads the semantic application of the first ordered applicative morph. The meaning has changed after the ordering of the second morph from pierce to another semantic context of shaping/making/drilling iron materials. Therefore, the first morph is a feeding one while the second is the breeding morph.

This is different from the ordering of applicative morphs of the same form (cf, table 1) whereby there is no breeding affix/morph. In other words the ordering of applicative-applicative (after the intervening of other morph) is allowed in Kiswahili language. The data in 19 illustrates:

19. *a)Pig-i-an-a*  
 Beat-APPL-REC-FV  
 ‘Beat for each other’

b)

*Pig-i-an-i-a*

Beat-APPL-REC-APPL-FV

‘Beat for each other with’

The data in 19) shows the ordering of applicative morph and reciprocal morph and in 19b) data, three morphs are ordered of which the two are applicative and the other is reciprocal. However, the meaning is transparent in the sense that each morph presents its semanticity. The first morph (applicative) is argumentative morph while the second applicative morph represents *reason* for doing such action.

The data from (Khamis, 2008) gives us another complexity of Swahili pairwise of verbal extensions, in the sense that not all morphs are transparent especially, non reproductive morphs in Kiswhili language. The data in 20 below explain the phenomenon:

20.	a)	<i>Fung-an-ish-an-a</i>
	Close-	REC-CAUSE-REC-FV
	‘Make to close for each other’	

	b)	<i>Fung-ish-an-ish-a</i>
	Close-	REC-CAUSE-REC-FV
	‘Make to caue to close for each other’	(Khamis, 2008:102)

The data in 20a) has three morphs and the meaning reflects the two morphs, this is due to the fact the reciprocal is a valence decreasing argument. Therefore, whoever, the reciprocal morph repeats does not add  $\theta$ -roles. Note that the gloss above is my own and not for the author cited, ever since Khamis did not provide glossing. However, the data in 20b) shows two causative morphs and one reciprocal morph. The gloss shows that each morph has its own figuration semantically. Therefore, the three morphs emanate the three arguments. Unlike the data (cf, 15) that show the ordering of two causative morphs of different form, the data in 20b) has a different conception with which the intervening of reciprocal has created environment for semantic dis opacity.

However, from the above base, the Swahili verb *funga* may be extended up to five morphs ordered together. The table in 3 below shows such form of ordering:

Table 3: The input word *fungishanishiwa* ‘Be made to caue to close for each other at’

	<i>	<ii>	<iii>	<iv>	<v>
<i>Fung-</i>					

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-ish-		+v(alence)
	-an-	-v(alence)
	-ish-	+v(alence)
	-i-	+v(alence)
	-w-	-v(alence)

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The five allomorphs shown above, shows that Kiswahili language verbs can order allomorphs up to five maximally apart from the general claim which shows that only four morphs are possible to be ordered in a single Kiswahili verb. Therefore, the step by step ordering shown in the above table shows that each morph plays its own semantics although it is difficult to process.

### ***Conclusion***

The pairwise of Kiswahili morph ordering of verbal extension play a great role in communication system in pertinent to its logical representations. As Kiswahili now is becoming a global communicative tool and in East African in particular, its grammar should not be generalized where inapplicable — either in written or spoken forms. Let written Kiswahili be differentiated from spoken Kiswahili for avoiding generalizations.

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**Examining the Role of Language, Culture and Communication Technology in  
Reconstructing Masculinity: A Reflection on Henry Ole Kulet's *To Become A  
Man***

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## **ABSTRACT**

This paper is an investigation on the role of language, culture and communication technology in reconstructing masculinity. The paper argues that there is an apparent disconnect between traditional and modern perspectives on what it means to be a man. The paper is guided by Raewyn Connell's notion of masculinity. The paper seeks to examine the disconnect between the African traditional perception and the modern view of masculinity. It also analyses the role of language, culture and communication technology in the reconstruction of masculinity. The information in this paper was gathered through literature review. Among the key arguments in this paper is that there is an apparent disconnect between the traditional and modern views on what it means to be a man. The paper also argues that there is need to reconstruct the African society's perception of what it means to be a man in order to render it relevant in modern society. The paper further argues that language, culture and communication technology can play a complementary role in achieving this goal.

**Keywords:** Masculinity, pre-modern, modern, femininity, patriarchal system, paradigm shift

## **Introduction**

Philip (2006) argues that in post-modern cultural discourse, the individual is socially constructed. As such, the only reality that is known is the one that is created. He therefore categorises masculinity and femininity as social constructs created for the individual as set rules that define the latter. The study interrogates masculinity in a supposedly pristine and colonial Kenyan Maasai society with Philip's assertion in mind. It highlights the strong influence of culture on the masculinity of the main protagonist, Leshao. Through the character of Leshao, Kulet critiques both traditional Kenyan notions of masculinity and modern, western values (modern masculinity brought by the missionaries through education).

### **1. Ole Kulet's depiction of the dramatic change in Maasai view of masculinity**

Leshao epitomises counter-hegemonic forces to the dominant mode of traditional masculinity. The paper explores a society in transition, and the changing faces of masculinities among the Maasai, through the life of the young protagonist Leshao. The young man struggles to understand "real manhood" as he is torn between

exogenous western values and the traditional Maasai (mis)conceptions of masculinities. The paper will seek to find out whether Leshao's "liberating" masculinities can break the shackles of traditional Maasai masculinity.

The paper also revisits the early forms of masculinity in the early black Kenyan society before Christianity and colonialism. Key to the paper is to understand how the pre-colonial and colonial Kenyan black man negotiates his masculinity during these two dispensations. Was there any conflict in the various ideas of masculinity? The paper reaffirms that the two key ideas of masculinity the section will be analysing are traditional masculinity (indigenous) and masculinity brought by the missionaries. Indigenous (traditional) masculinity is defined by tribal and group practices. On the other hand, the new version of masculinity is strongly influenced by Christian and western values. This paper argues that the latter is in a constant struggle with traditional masculinity for space within the Maasai socio-cultural context. The struggle originates in the clash between traditional, indigenous values and exogenous, western values as a result of colonialism. Hauff (2003) aptly captures the clash of these two very divergent cultures when she argues that despite the Maasai proving to be resilient, their culture is still very much threatened by industrialization and globalization. The above assertion points out to the role of modern communication and technology in the reconstruction of masculinity. The emergent forms of masculinities bring to fore the idea that masculinities are not static but fluid. Moreover, they are socially and historically constructed.

Pristine means before the communities in Kenya had any interaction with the Western or Arab world. Hence they were strictly following their cultures which were still uncorrupted or unsullied. The study focuses on Henry Ole Kulet's *To Become a Man*. The setting of the novel is in the Maasai community during the pre-colonial and colonial period.

Henry Ole Kulet centers his work during two periods. The period when missionaries had set up centers and were trying to venture into the interior of Kenya. The second period is when Kenya had become a British protectorate. In both periods, the Maasai community was experiencing a rapid transition from a traditional society to a modern society.

Hauff (2003) points out that the Maasai are one of the most celebrated tribes in Africa. The Maasai are a pastoralist group who have lived in Southern Kenya and Northern Tanzania for over 2500 years. They live communally and rely on their herds for subsistence (McCabe, Perkin, & Schofield, 1992:354).

The transition from tradition to modernity has several ramifications on the Maasai society's masculinities. There is a clash of two types of masculinities; traditional and modern. The Maasai traditional culture propagates an ideal form of hegemonic masculinity. This culturally exalted mode of masculinity is quite challenging to most men who cannot fulfill these public expectations. Nonetheless, they have to struggle so as to be accepted as "real men" by the patriarchal society. The patriarchal society wields a lot of power and there is a strong peer influence among men of different age-sets among the Maasai. The paper concurs with Donaldson's (1993) argument about the performance of hegemonic masculinity:

The public face of hegemonic masculinity, the argument goes is not necessarily even what powerful men are, but is what sustains their power, and is what large numbers of men are motivated to support because it benefits them. What most men support is not necessarily what they are. (Donaldson, 1993)

Donaldson's supposition infers that most men practice hegemonic masculinity so as to wield power over other men and women. However, men struggle to maintain that power. The biggest disadvantage for men, who want to express a divergent form of masculinity from the dominant mode, is the strong Maasai communal set-up. Hence there is a lot of policing for the enactment of these traditional masculine roles. The new version of masculinity introduced by the missionaries which is an anti-thesis of traditional masculinity is perceived (by the Maasai patriarchal society), as effeminate and subservient, compared to the traditional masculinity. The gate keepers of traditional masculinity (elders) enforce their "Ideal" version of masculinity through cultural

practices and groups of young warriors called Morans. Jackson (2002) aptly labels that diversion from the ideal masculine norms as “laddishness” (adopting “feminine attributes”).

### **3. Conflict between pre-modern and modern perceptions of masculinity**

The protagonist, Leshao, in *To Become a Man*, is torn between traditional Maasai masculinity and western concepts of masculinity. The father, a traditionalist, wants his son to go on raids so as to bring home more cattle. The father’s herd has decreased because he sold some cattle to enable Leshao go to school, the latter’s refusal to go for raids is an influence of western values that perceive raids as criminal acts. The most valued commodity in this community is the cow. Hence one’s wealth is measured according to the number of cattle in one’s herd. Homewood and Rodgers (1991) note that cattle ownership influences the construction of Maasai masculinity because men decide to get married depending on the number of cattle they own. Leshao’s father blames the son for the poverty that has engulfed the family. The old man believes that his eldest son has also brought dishonour to the family having acquired the tag of a coward who cannot go on cattle raids. Western values have influenced the school going Leshao, but the father will hear none of it. The father had sent the son to school after the missionaries had promised him that education would bring him more cattle. The father’s anger increases because Leshao’s age mates who never went to school have gone on many raids and brought many cattle to their fathers. On the other hand, Leshao still goes to school forcing the father to part with more cattle and yet the fruits do not seem to be forthcoming. The father is in a dilemma: the new culture that emphasises education as a tool of empowerment and the old order that values cattle ownership and raids.

Leshao who emerges from school is a changed young man who despises cattle raids as archaic. He detests the strong element of traditional Maasai masculinity. This really irritates the father. This pristine community still upholds traditional aspects of wealth creation and the issue of empowerment through education is still very alien. These two emerging perspectives of masculinities result in the clash between father and son. The father is a traditional Maasai man who is really entrenched in his culture. Mwangi (1990) notes the Maasai community is reputed to be one of the most positively impervious to

cultural hegemony. He argues that the community has resisted western value systems to retain a deep respect for their pre-colonial mores.

Hauff's (2003) assertion that the Maasai have resiliently struggled to maintain their culture points to the Herculean task Leshao faces. He is forced to negotiate different forms of masculinities in different contexts. These masculinities among Leshao's Maasai community are centered on cattle and pastoral culture, which influence the socio-economic forces in the community, and consequently influence male identities. These masculinities are socially constructed by the society he lives in. Morell (2001) argues that privileges and power are enjoyed by the people who keep the mores of a particular culture. On the other hand, others who have alternative masculinities are not considered "real men". Culture is one structure that holds so much power that an individual may not evade it. Leshao's community espouses a form of hegemonic masculinity to which an individual is forced to confirm. Young Leshao and another convert called Stefano, find themselves in this predicament. This dissent has ramifications.

In the first chapters of *To Become a Man*, the missionaries had started setting up schools. However, most of the people were not willing to send their children there. This is a resistant to the new age of education and communication technology. Leshao, is among the few young people who have joined school. The missionaries were trying to penetrate into the interior of the country: "Leshao was one of the herds boys, different from the rest in that he had gone to school. He still had one term to go..." (4). The father sends his son reluctantly after Leshao promises to bring more wealth to the family after finishing school, and also after the mother intervenes. During this period, most young Maasai men were joining moranship. These young men would later go for cattle raids. Such raids brought a lot of cattle which was a source of wealth. Leshao's father is in a dilemma and is not sure if the decision to send his son to school was right:

The old man had thought if the eight years a boy went to school were to train him to become a better moran, then the whole training was a failure since the ones who did not go to school made the best morans. The old

man was very annoyed at those boys who left school, not because he valued school more than he valued his skin sandals, but because their return cast doubt upon the promises his son often made to him, saying that as soon as he completed school he would be employed and would make him rich. His son's promises had once been backed by Reverend Walker (whom the Maasai simply called 'Waka'). (Ole Kulet, 1972:17)

Leshao's father is in a society in transition. Initially, upward mobility was through cattle raids and the acquisition of cattle. However, with the coming of the missionaries and colonialists, education is now slowly becoming the tool for upward mobility albeit with many challenges. Education is struggling to replace moranship and cattle raids in the social construction of Maasai masculinity. This brings to fore the malleability of masculinities. Maasai masculinities are not static but susceptible to change. An elder, Ole Nkipida, is one person who despite being a Maasai has embraced this change. He tries to convince Leshao's father that it is wise to embrace change because society is in transition. However, Leshao's father, Kerea ole Merresho will hear none of it:

'I wish you had gone around as I did and seen how the other young Maasai boys have progressed. They have bought better cattle than the ones we have. We should let our boys be like them. Let us not hinder them. You might not see the truth of it now, but I am telling you, we are being left behind by other villages because of encouraging our boys to join moranship, let alone cattle raids because they are becoming out of date and —'

'Stop, stop! If you were born a coward, you do not expect to convince others to be cowards. Are you not, ole Nkipida? Haven't you seen young boys of our village become rich overnight just by going on cattle raids.... (Ole Kulet, 1972:76)

#### **4 Reconstructing masculinity**

Education is perceived as a form of escapism from "real Maasai manhood" by the traditionalists like Leshao's father. According to the traditionalists, education is a kind of

a shortcut that avoids rigours that characterize true manhood like bravery, risk, violence and has “feminized” Maasai men. That is why Leshao’s father has the temerity to call a fellow elder a coward. The cowardly tag is a big insult especially in a community socialised into warrior hood. The conflict between the two opposing masculinities is evident and education is a catalyst for change. Though Ole Nkipida tries to convince Leshao’s father, Leshao’s father is very adamant that his son will never go to school. In fact, Leshao’s late mother is the one who convinces the old man to allow the young boy to attend school.

However, in this society, the voice of the woman is not given much space. Leshao’s father seems to have changed his mind about his son attending school, but does not want it to appear as if it was because of the mother. This scenario corroborates Spivak’s (1988) argument that the voice of the subaltern (in this instance, women in the Maasai male dominated society) is never given space. Spivak asks the key question whether the subaltern can speak. She points out the voice and space of the subaltern is subjugated in the dominant discourse consciously or unconsciously. De Beauvoir (1949) rightly defines Kereia ole Merresho’s perception of women. She explains that humanity is male and defines the female as the “other”. Giele (1978) also concurs with Beauvoir when he explains that stereotypical masculinity is portrayed as normal, natural and universal in many societies. Thus, how Kereia ole Merresho behaves against women is sanctioned by the society. Apart from being obstinate, the father exhibits excessive hegemonic masculinity. Talle (1988) contends that the Maasai are a male dominated society and women are subordinate in all aspects of culture. He points out that the Maasai culture promotes male dominance and subordination of women through customs such as clitoridectomy (female circumcision) and forced marriages. Messner (2004) observes that patriarchy (an ideology that privileges particularly old men) is a global phenomenon. Thus, patriarchy is not limited to the Maasai but to many societies worldwide. Messner further asserts that the biological fact of being male places men in privileged positions.

Leshao has to undergo major challenges so as to try to fit in a highly masculinised society. Connell (1995) explains that hegemonic masculinity is constructed through

difficult negotiations. Leshao and the father are victims of a dominant discourse in the strong Maasai patriarchal society. That is why the father is under pressure to make sure Leshao joins the raids and abandons school. Lorber (1994) points out that individual decision on gender-role expectations are mostly outweighed by societal expectations:

My concept of gender differs from previous conceptualizations in that I do not locate it in individual or in interpersonal relations, although the construction and maintenance of gender are manifest in personal identities and in social interactions. Rather I see gender as an institution that establishes patterns of expectation for individuals, orders the social processes of everyday life, and is built into the major social organizations of society, such as the economy, ideology, the family and politics. (28- 29)

Lorber's observation explains the predicament Leshao finds himself in. His individual will does not count much. His father and society expects him to follow the pattern previous Maasai men have followed. If the young man takes a different course it seems that he will be shunned. It is rather unfortunate that Leshao cannot ignore these societal forces. Omalla (1981) explains that among the Maasai, anyone who declined to go to war or raid cattle was considered a coward. Moreover, the so called "cowards" were not grouped with other men, but instead they were rejected. Leshao's father, in a dialogue with the young man, reveals this:

Your grandfather feared to go on raids and I only inherited ten cows from him. But my grandfather was brave. He fought alone and brought cattle everybody admired. Your grandfather saw them all go without increasing any. I wish I was not his son. 'But my son, what disturbs my heart is that you bear a resemblance to him. Your age-group have brought to their fathers and to themselves riches while you yourself continue to be a big pipe draining my wealth away. (Ole Kulet, 1972:5)

Leshao's father's tone reveals bitterness for the son who has not fulfilled the Maasai cultural concept of an ideal man.

Imms (2000) explains that: "Sociological theories represent masculinity as an investment in male-dominated historical and cultural social power structures" (1). Thus Leshao is held hostage by the cultural dynamics in his Maasai community that he has to fulfill. By virtue of his gender, the young man cannot escape the rigorous rituals so as to make him an ideal "man". Michael Foucault (1977), when theorising about gender and power, argued that power is located in the social structures such as social institutions that hold society together as opposed to individuals. Leshao is amidst these social forces that do not consider his individuality. The protagonist is striving to escape from this traditional dominant notion of masculinity, to the western notions of masculinity. The young man believes that the traditional modes of masculinity are outdated.

Leshao's father, apart from insisting on the son to go on raids, also wants him to get circumcised. The old man is preparing Leshao for circumcision and believes that maybe after the ritual, the young man would go on raids. Ole Merresho is an embodiment of a typical Maasai man who has not been influenced by outside cultures. He is the voice of tradition while Leshao is the voice of change. The old man expects circumcision to move Leshao from subordinate masculinity (associated with cowardice, marginalisation and not owning property) to hegemonic masculinity, which means owning property, courage and going on raids. To Leshao's father, the young man is an antithesis of an ideal man. Moreover, according to the Maasai, it is not any type of circumcision; but it must be traditional circumcision. The idea of going to hospital for this rite is really looked down upon. In fact, it is perceived as an act of cowardice. When Leshao's father gets information that the young man wants to go to hospital for circumcision, he becomes so angry:

To come to the point, I have been fearing that your quietness might be cowardice, cowardice of the knife and you might do what the idiot son of

Pushka did. If you did that you would not live to see the next sun, not if Kerea ole Merresho lived. I cannot imagine my son going to hospital, as if sick, just for the mere cutting of the penis ... I have been waiting and I have waited for long. Today when I told you that you would accompany the other young men on the raid, I expected you to tell me you were not yet circumcised.’(Ole Kulet, 1972: 14)

Circumcision is meant to prepare young men to be tough and bold. These masculine expectations are geared towards hegemonic masculinity.

Leshao pinpoints clearly that the pristine period is over. Hence, the Maasai man has to be dynamic and change with the times. Protections by the morans and going on cattle raids have become obsolete. However, this harsh reality is not going down well with the traditionalists like Leshao’s father, who are keen on maintaining their culture.

This paper argues that in traditional Maasai culture, hegemonic masculinity is based on the hyper-masculine ideal of the warrior and cattle raider. Leshao’s father is among the elders of the community and is transmitting the dominant culture to his son. The old man fails to understand that times are changing, and society is in a form of transition. The old order that held society together is under threat from foreign intrusion. Ironically, Ole Merresho’s nature and character is culturally praised in the Maasai culture. For instance, Leshao’s father beats up a man sent to force Leshao to go back to school. What had contributed to this conflict is the white man’s messenger called Stefano Malon (a Maasai converted to Christianity), who had exaggerated the white man’s message by adding threats to the old man (84). The messenger had told Ole Merresho that if Leshao never went back to school, the white man would send “askaris” (Policemen) to arrest the old man. These threats had worked up the old man. His reactions can be related to the culture of the Maasai man. Threats and intimidations are not to be tolerated:

But the old man was not of the type to be threatened. Without talking to

Stefano or warning him of what was to happen to him, he sprang up from where he was seated and jumped high into the air with his stick raised above his head. Then he brought it down full force to Stefano's shoulder. Before Stefano knew what was happening, the old man had cudged him several times. But Stefano was not the fighting type. Reverend Walker's teachings had softened him. Instead of striking back, the women heard him say, 'The Lord said, if one strikes your right cheek give him your left cheek too.' (Ole Kulet, 1972:84)

This incident highlights the clash between the modern and traditional masculinity. Leshao's father Ole Merresho, behaves in a typical traditional Maasai manly way. As expected, he aggressively confronts the visitor after being threatened. Not reacting would have been perceived by the traditional society, as an act of cowardice. Kerea ole Merresho is one very proud man who would never want to appear weak. On the other hand, Stefano is caught in between the two masculinities. The traditional Maasai masculinity that he was so strongly socialised that advocates aggression, and modern masculinity, taught by the white missionaries that preaches restraint. The missionaries' notion of masculinity is based on the Bible, particularly Jesus'. It abhors violence. Nevertheless, the study opines that Stefano is struggling to discard the traditional Maasai masculinity. Traditional masculinity is quite evident by the way he initially approaches the old man. He adds threatening words to the initial message. Stefano really struggles not to react when he faces Ole Merresho's wrath. Stefano is not his usual self. His retaliation is governed by the notions of masculinity based on the Bible that he has inculcated at the mission centre. This is a man in crisis. In fact, the villagers are so stunned and disappointed in him that they remain perplexed. The elders who represent true Maasai traditional masculinity in a dialogue reveal this disappointment in Stefano:

As the episode was narrated, one of the elders could not help but add his own moral. 'Surely there is stupidity in being a black Olashumpia.'

'There is no doubt about that,' the other agreed. 'I knew Malon very well.'

We were together in moranship and he was a brave man.’

‘I knew him too,’ the other put in.’ I can remember when our manyatta fought their manyatta. When his men retreated he knelt down and refused to move. Men of his clan who were of our manyatta defended him and a fight broke out again within our manyatta. I am indeed surprised how Waka has tamed him. They recalled many instances in which Malon had proved himself a great warrior. Leshao listened quietly, feeling pity for him. (Ole Kulet, 1972:85)

“Olashumpia” refers to the new Maasai converts who have embraced Christianity. “Waka” refers to the white man. Leshao feels pity for Malon(Stefano). Leshao and Malon(Stefano) are both caught between traditional Maasai masculinity that is so much rooted in their culture, and western notions of masculinity that they have recently acquired, after their interaction with missionaries at the mission centre. Despite trying to discard the traditional masculinity for the new form, it still haunts them and they cannot easily discard it. The duos’ (Malon and Leshao) position as counter-hegemonic forces comes with a lot of alienation. Abandoning traditional masculinity comes with consequences and repercussions. For instance, the cowardly tag Malon now wears in the village is a very strong challenge to his masculinity. It is a symbol of emasculation in this war-like community. Malon’s scenario is even worse because he is assaulted before women: “The elders then knew what had happened. They split themselves into two groups. One beat the woman away from the scene ...” (85).

Leshao’s pity for Malon can also be attributed to the type of patriarchal socialisation that the former has been socialised. He knows that Malon should have reacted. This type of patriarchal socialisation which lays a lot emphasis in strength and bravado is called machismo. It is a type of masculinity that dwells on the repudiation of all attributes that display any sign of “weakness” or femininity. Hence, Stefano’s reaction strongly opposes this socially dominant form of machismo. Stefano restrains himself, thus, losing face before the elders. The elders are the bearers of this aggressive form of masculinity. They

are what Donaldson (1993) calls “weavers of the fabric of hegemony” (11). He argues that such people regulate, manage gender regimes and interpret gender relations. Malon’s ego and self esteem is really dented in the village. Stefano has been assaulted without reacting, and he has been told to leave for his own safety. The price of subverting “real manhood” can sometimes be very costly and painful. Leshao also has to flee the village rather than go on a cattle raid. His “cowardly” act turns him into an outcast like Malon. The town which is the centre of modernity becomes his place of refuge. Leshao encounters a new version of masculinity, whereby the construction of masculinity is not pegged on the number of cattle one has, but education and employment. Nevertheless, just like Malon, the traditional aggressive and violent masculinity is still part of him. He beats up a guard who prevents him from meeting Walker, the missionary mentor that had taken him to school:

Leshao was enraged. His actions were sharp and quick. He grabbed a piece of wood which lay on the ground and jumped at the man, hitting him thrice on the head. The man grabbed him and they both struggled. Leshao was stronger and in the next moment the man was on the ground and Leshao was hitting him hard on his head. (Ole Kulet,1972:125)

Though Leshao has passed through the mission centre, he finds it hard to discard the warrior hood moran mentality he was socialised into. Unlike Malon, he cannot restrain himself when provoked. This part of Christian masculinity of forgiveness and tolerance becomes a thing of the past in this new moran initiate. Leshao’s violent nature forces him to miss an opportunity to see Rev Walker and secure a job. He is instantly dismissed by the enraged reverend “I have no work for a fighter,’ Walker shouted back” (126). In the village, Leshao would have been a hero through his actions but in the city he is a villain. Leshao’s actions quite clearly depict the challenge of totally discarding traditional forms of masculinity. The reverend even reminds Leshao of his father’s actions when the former had sent Malon “The other time I sent Stefano to come and see you and your father assaulted him and now you come and assault Jeremia at my home.”(126) Walker’s reference to that earlier incident, brings to fore the important role fathers play in the construction of their progenies masculinities. Leshao father is a poor role model and the

son has imbibed that violent nature. The fact that missionary education has not changed the young man, makes the study conclude that Kerea ole Merresho is a failed patriarch. Leshao's violent masculinity jeopardises the young man's stay in the city because everybody refuses to employ him:

For the following two months Leshao wandered from office to office first, then from shop to shop, then from hotel to hotel, and finally from home to home. But wherever he went, prospective employers turned him down saying they were not prepared to employ a person who fought with his would-be workmates. (Ole Kulet, 1972:127)

Leshao's transition to modern masculinity suffers more when his host, Pushka chases him out of the house because Leshao seems to have become a burden. The young man cannot believe it. This new urban masculinity does not really entertain communalism and dependence. Leshao's violent nature haunts him again when he refuses to leave Pushkin's house and is later arrested by the police. The arrest is quite humiliating to the young moran whose masculinity is dented when he does not fight back:

The third policeman came forward and slapped him on the face. It was the first time since he had been circumcised that a man had slapped him. At first he thought of revenge and he took one step toward his sword, but he quickly weighed the situation and gave up the idea. (Ole Kulet, 1972:129)

Leshao's failed masculinity in the city and subsequent return back to the village is quite humiliating to him. The young man is an outcast in both traditional and western masculinity. The tag of cowardice is too painful for a Maasai moran to bear. Leshao cannot fathom the subordinate tag that he will have to live with. The town was the place of escape from what he considered as outdated masculine practices like cattle raids. However, modern masculinity seems to have rejected him. Leshao's father even opts to leave the village because of the shame that the son had deserted moranship. This situation forces Leshao to strive to redeem his wounded masculinity. He decides to turn to the traditional form of redemption; cattle raids. This is the only way that the young man feels

he can gain respect from the father: “The raid was re-organised that night to allow Leshao to join” (131). Unfortunately, the raid is not successful. Leshao loses a leg and is later taken to court and sentenced to fourteen years imprisonment. Though Leshao suffers the agonising pain and incarceration, his masculinity is “redeemed”. The action re-unites him with the father. The young man has paid the price of manhood in a traditional perspective thus becoming a hero in the village but a prisoner in the modern set-up. Ole Kulet’s text explains the clash of two masculinities in a society in transition. Leshao’s hybrid type of masculinity does not seem to work.

## CONCLUSION

Henry Ole Kulet’s text *To Become a Man* has effectively depicted masculinity in a transitional Maasai community. The study has established that the dominant form of masculinity in the pristine Maasai community is traditional hegemonic masculinity. It is a form of masculinity constructed in a dominant, aggressive and violent manner. Characters (Malon and Leshao) who attempt to subvert this dominant form of masculinity face a lot of resistance. The societal forces that perpetuate the old traditional masculinity resist vehemently. It is quite prudent to argue that change especially cultural does not come easily. Agents of change such as education face a lot of resistance in this rigid society. The study also contends that culture and language (discourse of communication) are used as a vehicles to propagate masculinist sexual ideologies by agents like the traditional Maasai patriarchal society. The group uses the two to perpetuate the narrative of traditional masculinity as the ideal form of masculinity. The traditional masculinity in this chapter clearly fits into Donaldson’s (1993) description of hegemonic masculinity. Donaldson argues that hegemonic masculinity can be negated, challenged, renounced, imposed, constructed with difficulty, modernised but not necessarily enjoyed. He further argues that this form of masculinity that passes itself as natural can harm, deform, deny but not necessarily satisfy. The paper agrees with Donaldson that this form of Maasai traditional masculinity propagates cultural ideals that do not correspond to the real personalities of most men. On the other hand, the new modern version of masculinity brought by the missionaries seems to borrow heavily from the teachings of Christ. It can be categorised as a form of Christian masculinity that negates hegemonic attributes of

masculinity such as aggression and violence. It espouses values such as forgiveness and non-violence which are categorised by most patriarchal societies as subordinate.

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**Students' Knowledge of HIV/AIDS and Their Attitude towards Sexual Behaviour in  
Coast Region, Kenya**

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## **ABSTRACT**

The HIV/AIDS and life skill education in Kenyan secondary schools was intended to reduce HIV/AIDS infection and stigmatisation of people living with HIV in the education sector. However, it is not known how implementation of the policy has affected students' knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in Coast Region of Kenya. The research study therefore investigated the relationship between students' knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in coast region of Kenya. The target population was 108693 respondents in 362 public secondary schools in the Coast Region of Kenya. Purposive and random sampling methods were used to choose the participants. The samples comprised of 388 students of which 193 were Form 1 and 195 were Form 4 students in 13 secondary schools. Questionnaires and test were used to collect the data. The validity of the instruments was checked by other experts in the field of research at Chuka University. The instruments were piloted in three secondary schools in Kilifi County within the Coast Region of Kenya to establish their reliability. Test-retest method was used to compute reliability coefficient from the data collected from the pilot study. Reliability coefficient of the instruments was 0.8 for each instrument. The descriptive statistics used were frequencies and percentage. Chi-square statistics was used to test the hypotheses in the study. The hypotheses testing was done at  $\alpha = 0.05$  level of significance. The data collected in this study was analysed using Statistical Package for Social Sciences (SPSS) computer programme version 20.0. The research findings established that there was a positive relationship between the percentage of Form 1 students' with high knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in Coast Region of Kenya. It was therefore recommended that HIV/AIDS and life skill education be enhanced in secondary schools in order to cut down HIV infection among the secondary school students. The study findings also revealed that there was negative relationship between Form 4 students' with high knowledge of HIV/AIDS and their attitudes towards sexual behaviour in secondary schools in Coast Region of Kenya. It was therefore recommended that secondary school education should be geared towards inculcating positive attitude towards sexual behaviour among students

in secondary schools in Coast Region of Kenya.

**Key Words:** Attitude, Knowledge, Sexual behaviour, Stigmatization, Life skill, education

## 1. INTRODUCTION

Agbemenu (2009) reported that sex education that was to address HIV and AIDS was first taught as a subject on its own but this module changed when the concepts were integrated within other teaching subjects in Kenyan secondary schools. The withdrawal of sex education as a subject was due to the outcry by the society against it in schools. According to AVERT (2010), failure to implement sex education gave rise to integration of sex education in other subjects and also introduction of life skills education in secondary school curriculum.

Life skills education and HIV/AIDS education in many countries has been reported to have succeeded in reducing incidence of risky sexual behaviour among students (Henderson, Wight, Raab, Abraham, Buston & Scott., 2002; Chinsembu, Siziya, Muula & Rudatsikira., 2004). It has also been reported that students' knowledge and perception on HIV/AIDS increased depending on when students were taught about HIV and AIDS (Jahanfar, Lim, Loh, Yeoh & Charles, 2008; Madeline, Felicia, Pierre, Sagina, Sonal, Warren-Jeanpiere, & Sandra, 2011). Selim and El-Shereef (2010) showed that students had satisfactory knowledge about AIDS in a study carried out in Egypt. A statistically significant improvement in students' knowledge of HIV and AIDS was revealed after implementation of HIV/AIDS education in the same study (Selim & El-Shereef, 2010). The success of HIV/AIDS education was determined by successful implementation of the programme in schools among the intervening countries. However, studies by other researchers showed that as students' knowledge of HIV/AIDS increased, their sexual behaviour remained risky or the same.

According to Boyce Doherty Fortin and Mackinnon (2002), students' knowledge of HIV/AIDS and their risky sexual behaviour increased as students moved from one academic level to the next in a study carried out in Canada. Bekeny (2009) in a study

carried out in Yaoundé-Cameroon found out that HIV/AIDS interventions in schools impact moderate behaviour changes, and that there was weak correlation between HIV/AIDS education and students' attitudes towards People Living with HIV (PLHIV).

A study by Fawole, *et al* (2011) showed that 73.6% of students in Nigerian Universities had high knowledge of HIV/AIDS but majority of them were involved in risky sexual behaviour. Mongkuo, Mushi, and Rollinda (2010) found out that most of the students surveyed in South-Eastern United States were knowledgeable about HIV/AIDS and understood the risky behaviour associated with HIV/AIDS. However, it was willingness to associate with PLHIV which was the predictor of students' willingness to practice safe sex. In a survey carried out in 2005 among students in South Africa, most (82%) of the youth males and 83% of females viewed themselves as being at no/or small risk of HIV infection despite the high HIV infection rate in that country (Kermyt, Beutel & Maughan-Brown, 2007). According to Nath (2009), Youth in India were found to be aware of the HIV and AIDS but a higher percentage of the males reported engaging in premarital sexual activity compared to females. The study also revealed that condom awareness among the youth was fairly high but condom usage was reported to be low.

Adimora, Mitchell and Yotebieng (2009) showed that students did not see themselves as susceptible to HIV and AIDS and believed condom effectiveness in preventing HIV to be low in a study that was carried out in Nairobi, Kenya. According to Abebe and Mitikie (2009), students in Ethiopia had knowledge on VCT services but very few of them had undergone VCT. World Health Organisation (WHO, 2007) reported that in general adolescents between the age of 10 to 19 years and particularly girls were at high risk of getting infected with HIV. Report by other researcher show that many of the young people do not seek voluntary counselling and testing (VCT) services until they develop symptoms of AIDS in Kenya and that majority of the youth were engaged in risky sexual behaviour more than any other age group in Kenya (Waithaka & Bessinger; 2001; Kiragu, 2001; Onyando & Otieno, 2003). However, these studies were carried out long time ago and there was need to re-evaluate the success of sex education and life skill education in Kenyan secondary schools.

## **1.2 statement of the problem**

Human resource is a major factor in Harnessing Science, Research and Technology for Sustainability development (HSRTSD). This is because educated population is required in achieving the objectives of HSRTSD. However, the information in the media show that HIV and AIDS is threat to students who are looked upon to play important role in achieving HSRTSD objectives and future implementers of HSRTSD objectives. It is not known HIV/AIDS education affect secondary school students' knowledge of HIV/AIDS and their attitude towards sexual behaviour in Coast Region of Kenya. The present study investigated secondary school students' knowledge of HIV/AIDS and their Attitude towards sexual behaviour in Coast Region, Kenya.

## **2. Objectives of the study**

The study purposed to;

1. Investigate the relationship between Form 1 students' knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in coast region, Kenya.
2. Investigate the relationship between Form 4 students' knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in coast region, Kenya.

## **3. Research Hypotheses**

The following null hypotheses were tested at  $\alpha = 0.05$  level of significance;

H0<sub>1</sub>: There is no significant relationship between the percentage of Form 1 students with high knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in coast region, Kenya.

H0<sub>2</sub>: There is no significant relationship between the percentage of Form 4 students with high knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in coast region, Kenya.

## **4. Methodology**

The study adopted a descriptive survey research design. The target population was

108693 respondents in 362 public secondary schools in Coast Region, Kenya. The selection of schools was done using simple random sampling methods while participants were selected using purposive and simple random sampling methods. The sample comprised of 388 students of which 193 were Form 1 and 195 were Form 4 students in 13 secondary schools from Coast Region, Kenya. Data was collected using test to get students' knowledge of HIV/AIDS and questionnaire to get students' attitude towards sexual behaviour. The students who did the test also filled the questionnaire that measured their attitude towards sexual behaviour. The pilot study was carried out in three schools in Kilifi County within the Coast Region, Kenya. The test re-test method was used during the pilot study to obtain data that was used to compute reliability correlation coefficient. The test and questionnaire yielded a reliability coefficient of 0.8 each. The research tools were developed and validated before use with help from other members in the Department of Education. The researcher obtained letter from Chuka University that was used to obtain permission to carry out the study from National Commission for Science, Technology and Innovation (NACOSTI). The data collected from the field was analyzed using frequencies, percentages and Chi-square statistics. The data in the study was analysed using statistical package for social sciences (SPSS) computer programme version 20.0. The results were presented using frequency, percentages, tables and bar graphs.

## **5. Results of the Study and Discussion**

The study was set to investigate the relationship between students' knowledge of HIV/AIDS and their attitudes towards sexual behaviour in secondary schools in the Coast Region of Kenya. Information was collected from 388 respondents and the data analysis generated the following results:

### **5.1 Students' Knowledge of HIV/AIDS and Their Attitude towards Sexual Behaviour**

The Null hypothesis one sought to find out whether there was a significant relationship between the percentage of Form 1 students with high knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in Coast Region of Kenya. The

researcher used test and questionnaire to collect the data from the same respondents which was analysed using descriptive statistic and Chi-square test. The data used had been collected in the previously published research studies (Thuo, 2016; Thuo *et al.*, 2016a & Thuo *et al.*, 2016b). The results were summarised in Figure 1.

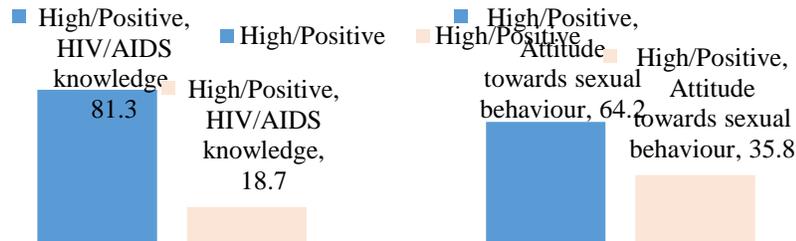


Fig 1: Relationship between Form 1 students' knowledge and their attitude towards sexual behaviour

Figure 1 shows that 83.3 % of Form 1 students had high knowledge of HIV/AIDS and 64.2% had positive attitude towards sexual behaviour. However 18.7% of the Form 1 students had low knowledge of HIV/AIDS but 35.8% of them had negative attitude towards sexual behaviour an indication that some of the students with High knowledge of HIV/AIDS had negative attitude towards sexual behaviour. In order to test the stated hypothesis, the data was subjected to Chi-square test and the results were summarised in Table 1.

Table 1

Chi-square Test between Form 1 Students' Knowledge and Their Attitudes

	Students' HIV/AIDS knowledge	Students' attitude towards sexual behaviour
Chi-square	75.860	15 .674
df	1	1

Asymp. Sig.

.000

.000

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The information in Table 1 shows that there is significant relationship between Form 1 students knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in Coast Region of Kenya ( $\chi^2 = 75.860, df = 1, p < 0.05$ ;  $\chi^2 = 15.674, df = 1, p < 0.05$ ). The Null hypothesis that stated that there is no significant relationship between the percentage of Form 1 students with high knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in Coast Region was rejected.

The findings are consistent with that of Henderson *et al* (2002) that showed that education is necessary in reducing the spread of HIV/AIDS among the students in East Scotland. Visser (2005) also found out that learners' knowledge of HIV and AIDS increased and their attitudes were more positive after students were taught HIV/AIDS education in a study carried out in South Africa. Chinsebu *et al* (2004) in a study carried out in Namibia observed that secondary school students' risky sexual behaviour reduced after they were taught about HIV/AIDS. However it should be noted that Form 1 students in this study had just started secondary school education and that much of the HIV/AIDS and life skill education and sexual behaviour could only be attributed to what they learned in primary school. To shed more light on relationship between Form 1 students' knowledge of HIV/AIDS and their attitude towards sexual behaviour, students were asked to indicate if they would disclose their HIV status if they were HIV positive. The results were presented in Fig 2.

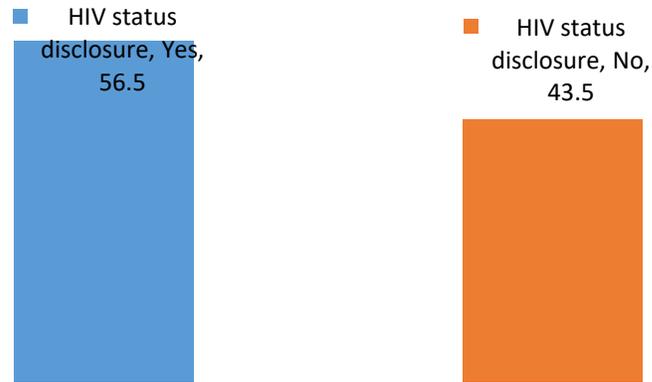


Fig 2: Form 1 status disclosure

The information in Figure 2 shows that 56.5% of Form 1 students would disclose their HIV status if they were HIV positive. Information in Figure 2 also revealed that 43.5% of Form 1 students stated that they can not disclose their HIV status if they were HIV positive. However, information in Figure 1 showed that 64.2% of Form 1 students had positive attitude towards sexual behaviour and 33.8% had negative attitude towards sexual behaviour. Information from Figure 1 and Figure 2 shows that there was significant number of Form 1 students who had positive attitude towards sexual behaviour but could not disclose their HIV status if they were HIV positive. According to Ngotho (2005) stigma associated with being HIV positive prevent students from disclosing their HIV status.

The Null hypothesis two sought to find out whether there was a significant relationship between the percentage of Form 4 students with high knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in Coast Region of Kenya. The researcher administered test and then gave the same Form 4 students questionnaire to fill. The test and the questionnaire were similar to those of Form 1 students (Thuo *et al.*, 2016a & Thuo *et al.*, 2016 b). The results were summarised in Figure 2.

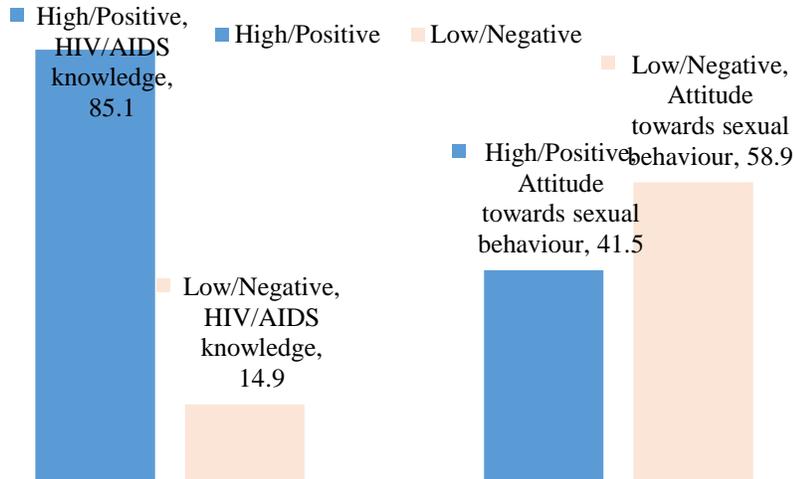


Fig 3: Relationship between Form 4 students' knowledge and their attitude towards sexual behaviour

Figure 3 shows that 85.1 % of Form 4 students had high knowledge of HIV/AIDS and 41.5% had positive attitude towards sexual behaviour. However 14.9% of Form 4 students had low knowledge of HIV/AIDS but 58.9% of them had negative attitude towards sexual behaviour an indication that most of Form 4 students with high knowledge of HIV/AIDS had negative attitude towards sexual behaviour. In order to test the hypothesis, the data was subjected to Chi-square test and the results were summarised in Table 2.

Table 2

Chi-square Test between Form 4 Students' knowledge and their Attitudes

	Students' HIV/AIDS knowledge	Students' attitude towards sexual behaviour
Chi-square	96.251	5 .585
df	1	1
Asymp. Sig.	.000	.018

The information in Table 2 shows that there was significant relationship between the percentage of Form 4 students with high knowledge of HIV/AIDS and their positive attitude towards sexual behaviour in secondary schools in Coast Region of Kenya ( $\chi^2 = 96.251, df = 1, p < 0.05$ ;  $\chi^2 = 5.585, df = 1, p < 0.05$ ). The Null hypothesis that stated that there was no significant relationship between the percentage of Form 4 students with high knowledge of HIV/AIDS and their attitude towards sexual behaviour in secondary schools in Coast Region was rejected.

The information in Figure 2 and Table 2 showed that there was a negative relationship between the percentage of Form 4 students with high knowledge of HIV/AIDS and their positive attitude towards sexual behaviour in secondary schools in Coast Region of Kenya. The result is consistent with that of other researchers. Boyce *et al* (200) in a study carried out in Canada observed that as students progressed from grade 7 to 11, their HIV/AIDS knowledge and their risky sexual behaviour increased. A study by Fawole *et al* (2011) showed that 73.6% of students in Nigerian Universities had high knowledge on HIV/AIDS but majority of them were involved in risky sexual behaviour. According to Nath (2009), Youth in India were found to be aware of the HIV and AIDS but a higher percentage of the males reported engaging in premarital sexual activity compared to females. The study also revealed that condom awareness among the youth in India was fairly high but condom usage was reported to be low. According to Sharlene, Maren and Gisela (2011), adolescents need correct information about their bodies, about sex and sexuality and about HIV and AIDS. They also need guiding values for their relationships especially with people of the opposite sex. With sound knowledge and good values, they

are able to prevent sexually transmitted diseases including HIV. To shed more light on the relationship between Form 4 students' knowledge of HIV/AIDS and their attitude towards sexual behaviour, students were asked if they would disclose their HIV status if found to be HIV positive. The results were summarised in Figure 4

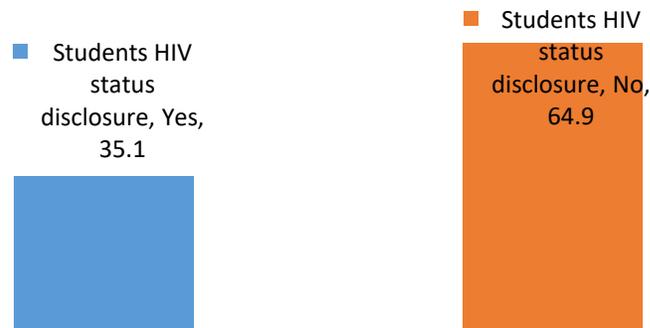


Fig 4: Students HIV status disclosure

The information in Figure 4 shows that 35.1% of Form 4 students would disclose their HIV status if they were HIV positive. Information in Figure 4 also revealed that 64.9% of the Form 4 students stated that they can not disclose their HIV status if they were HIV positive. The high percentage of Form 4 students who could not disclose their HIV status was most likely because majority of them could be sexually active and therefore feared stigmatisation associated with being HIV positive (Ngotho, 2005).

## 6. Conclusion and Recommendation

The findings of the research study showed that there was a positive relationship between the percentage of Form 1 students with high knowledge of HVI/AIDS and their positive attitude towards sexual behaviour in secondary school in Coast Region of Kenya. The researcher therefore recommended that secondary school should implement the HIV/AIDS and life skill education to reduce HIV infection among secondary schools in Coast Region of Kenya. The study however, revealed that there was a negative

relationship between the percentage of Form 4 students with high knowledge of HIV/AIDS and their positive attitude towards sexual behaviour in secondary schools in Coast Region of Kenya. Most of the students had negative attitude towards sexual behaviour despite their high knowledge of HIV/AIDS and the researcher recommended that HIV/AIDS and life skill education should also focus more on improving students' attitude towards sexual behaviour. This can be achieved by teaching students more about good cultural values concerning sex and sexuality and in providing holistic education that takes care of students' academic and moral needs.

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**Advancing Afrikan Indigenous Sustainable Practices for Transformative  
Development: The Mau Ogiek People, Kenya**

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**ABSTRACT**

Globally, one main concern of the minorities is the right to practice and preserve their culture unconstrained and protect their identity. The Mau Ogiek, are an ethnic minority, forest-dwelling hunters and gatherers who embody Afrikan indigenous sustainable practices in their culture. However, the significance of the practices is not acknowledged in the attainment of the United Nations' *Sustainable Development Goals* (SDGs) and Kenya's *Vision 2030* as well as the *BigFour*: manufacturing, food security, agriculture and universal health care coverage. This paper unpacks the Mau Ogiek's indigenous sustainable practices to date. An ethnographic study was conducted in the Mau Forest Complex, Nessuit location, with a population of about 2600 Mau Ogiek. Judgement sampling was employed to select 84 consultants. Data collection involved key-consultant in-depth interviews, focus group discussions, observation and artifact analysis. Data analysis used thematic and qualitative content analyses. The ethnic dress' sustainable characteristics include multiple styles and functions, up-cycle, use of natural dyes and locally available materials, not wasteful and hand-me-down in addition to entrepreneurship. Indigenous practices ensure sustainable peace within and without the community through provision of cultural services, borrowing from and trading with neighbouring communities, cultural authentication, fixing beehives in one's territory and equitable resource allocation and consumption. Other indigenous sustainable practices comprise food security, environmental management whereby honey is harvested sustainably and sacredness of trees. Meritocracy and gender equality are highly valued too. Significantly this paper demonstrates that the Mau Ogiek's indigenous sustainable practices advance contemporary design interventions for sustainable development, in fashion production and consumption, environmental management, food security, entrepreneurship, peace and appropriate technology and should be adopted with the community's engagement. Further, it addresses the United Nations' *Sustainable Development Goals 1, 2, 8, 9, 12, 13, 15 and 16* and adopts human-centered design approach to provide a better *quality of life* for all.

**Keywords:** Afrikan, Dress, Indigenous, Mau Ogiek, sustainable practices,

## INTRODUCTION

### The Mau Ogiek People

Globally, minority groups' main concern is the right and desire to preserve and practice their culture unconstrained and to protect their identity (International Crisis Group [ICG], 2003). The Mau Ogiek people are an ethnic minority, forest-dwelling hunters and gatherers who inhabit and claim the Mau Forest Complex in Kenya their ancestral land. Ogiek means "caretaker of all" plants and animals (Ogiek Peoples' Development Programme [OPDP], 2017). Historically the people made their living through hunting wild animals, mainly hyrax and bushbuck, beekeeping, killing various birds and gathering wild edible fruits and herbs in the forests. Beekeeping is their major economic activity. Culturally honey is highly valued for food, traditional brew, medicine, trade, legal compensation and dowry (Kimaiyo, 2004; Ng'ang'a, 2006). The community has faced diverse challenges such as ethnic minority status, evictions from the Mau Forest Complex by the colonial administration and later by successive independent governments and a ban on game hunting by the Kenya government in 1977 (Kimaiyo, 2004). Some ethnic groups use derogatory terms in reference to the people namely *Dorobo* or *Il-Torobo* "a poor person who has no cattle and who therefore lives on the meat of wild animals" (Ng'ang'a, 2006). Despite the discrimination and challenges, the Mau Ogiek uphold, conserve and preserve their culture, both material and non-material culture. The Ogiek cultural centre was opened in June, 2015 at Marioshoni (Correspondent, 2015). The Ogiek peoples' population is 78,691 or 0.20% of the total Kenyan population (Kenya National Bureau of Statistics [KNBS], 2010). Since time immemorial the community adopted indigenous sustainable practices.

Sustainable development is a visionary development paradigm that calls for a convergence between three pillars: economic development, social equity and environmental protection. However, over the past 20 years it has often been compartmentalized as an environmental issue and the reigning orientation of development as purely economic growth, especially by developed countries (United Nations, 2010). Hence, the majority world, Africa included is left to play catch-up with the developed countries. However, diverse communities have developed and employed

indigenous sustainable practices in their cultures, be they social, economic or environmental. Adoption of indigenous sustainable practices can play a major role in the attainment of United Nations *Sustainable Development Goals* (SDGs) such as Goal 1, 2, 8, 9, 12, 13, 15 and 16.

## **STATEMENT OF THE PROBLEM**

The discourse on sustainable practices for the past 20 years has emanated from the developed countries, with no regard to time-tested indigenous methods, found in Afrika and the majority world in general. The indigenous practices, adopted since time immemorial by diverse ethnic groups have sustained their cultures leading to positive social, economic and environmental impacts. However, the indigenous practices especially, Afrikan practices, such as those of the Mau Ogiek remain largely undocumented despite their huge potential in influencing the attainment of diverse UN *SDGs* and Kenya's *Vision 2030* and the *Big Four*.

## **LITERATURE REVIEW**

### **Sustainable practices in fashion production and consumption**

The fashion industry requires a more holistic and systemic thinking approach to sustainable design, one that takes into account not only how fashion is produced, but also its consumption. Sustainable consumption will not be achieved by the work of a single entity, but through collaborative innovation across the value chain and engaging consumers in a redefinition of value (Hutter, Capozucca & Nayyar, 2010).

Generally sustainable/cleaner production is the creation of goods and services using processes and systems that are: safe and healthy for workers, communities, and consumers; and, socially and creatively rewarding for all workers; majorly use locally and regionally created products and services; do not require foreign sources of capital in order to develop and grow; design and create products and services that are durable, repairable, easily bio-degradable and recycled. The products' packaging should use the minimal amount of material and energy possible and; change consumers to customers through education (Sustainable, n.d). Sustainability advocates focus on water and fossil

fuel scarcity, such as the cultivation and processing of cotton which consumes large quantities of the two resources in almost direct proportion. Approximately 65kWh of energy is saved for every kilogram of cotton replaced by used clothing (Dissanayake &Sinha, 2012). Additionally, is the use of vegetable tannin instead of chromium for leather processing.

Synonyms for sustainable fashion include eco-fashion, green fashion and slow fashion among others. This paradigm shift has spurred designers globally to investigate alternative materials and to link pleasure and fashion with awareness and responsibility. “[Slow] is simply an approach in which designers, buyers, retailers and consumers are more aware of the impacts of products on workers, communities and ecosystems” and moving away from “quantity to quality” (Craft Alliance, 2012). The prospect of limits on natural fibres and leather are pushing the fashion industry to find alternatives (The New York Times, 2017).

Fashion production is unsustainable, that is, the products and services, production processes, workers and community. In Kenya the manufacture of textile and apparel, and dyeing and leather is categorized as moderate and high energy-intensive respectively (Ecocare International Ltd, 2013). Although most of textile solid waste originates from household sources, waste textiles also arise during textile and apparel manufacture and from the retail industry negatively impacting the environment (Saha, 2014) which calls for the application of 3Rs (reduce, reuse and recycle) in its management. Reuse or recycling discarded fashion items reduces the negative environmental impact significantly (Dissanayake, &Sinha, 2012). Reuse of solid waste such as cut-pieces of fabrics, rejected pants, shirts and t-shirts, zippers, buttons, thread, elastic fasteners, used plastic packets, broken cloth hangers and empty bobbins means converting them into useful materials. Ninety-nine percent of used textiles are recyclable. Recycling entails reprocessing used clothing, fibrous material and clothing scraps from the manufacturing process into a new consumer product, often of lesser quality (Saha, 2014). Fishing nets, carpets and plastics recovered from beaches are also recycled. In support of animal welfare, laboratory-grown bio-fabricated leather, fur, silk and suede have been produced

from mushrooms, spiders and fruit waste among other sources (The New York Times, 2017).

Sustainability in fashion production also entails the design and construction of reversible fashion products and textile furnishings; use of end-of-line (EOL) fabrics/materials; up-cycle; restyle/refashion; entrepreneurship and; respect and enhancement of communities related to any stage of the product lifecycle. A reversible textile furnishing is one without true inside out thereby change the interior décor with a single product. Reversible apparel applies the same concept. Reversibility is attained through the use of double faced fabrics, stitching and neatening raw edges and no tags. Majority (82%) of the respondents approved of reversible textile furnishing citing, they are economically beneficial, ease for usability, rapid change of décor using the single product, creativity, appealing, fashionable and neat finish (Ramsamy-Iranah & Budhai, 2013). When consumers purchase such products they implement *SDG 12* on sustainable consumption, while a designer who creates sustainable products embraces *SDGs 9, 12 and 13* on sustainable production and takes action to combat climate change and its impact.

The EOL fabrics are made of natural fibres such as silk, wool, linen, organic cotton, bamboo, bark and leather, hence bio-degradable. José, a Ugandan fashion designer combines bark cloth with cotton, silk and linen to manufacture fashion products. The designer engages in tree planting with a non-governmental organization in Uganda to sustain bark production (*The Monitor*, 2015), hence conserving the environment. Up-cycling is the process of converting waste material/fabric or useless products into beautiful products of higher quality/value than or the same value as the original one or higher environmental value. By producing up-cycled items designers keep material out of landfills and protect natural resources being harvested unnecessarily for new products (Hipcyle, n.d). Patchwork and applique techniques conserve the environment. Restyle or refashion entails changing apparel, fashion accessories or soft furnishings from one style to another, instead of discarding it. A pair of jeans trousers converted to a handbag, used curtain refashioned to scatter cushion covers or a gathered skirt restyled into culottes. Sustainable fashion also comprises multi-functional, multi-style and multi-size apparel

and accessories as well as products that grow with the end-user. For instance, a scarf that can also be worn a blouse.

Fashion consumption and sustainability are often opposing ideas. The former is a highly resource-intensive and wasteful practice. Sustainability frowns on wasteful consumption. Sustainability in the fashion business is still an emerging agenda and authors such as Young et al., Pears and Fletcher have recognized the importance of investigating how sustainability could be achieved (Dissanayake & Sinha, 2012). Sustainable consumption requires consumers to buy less, use products longer and produce less waste (Armstrong et al., 2016).

### **Sustainable practices in entrepreneurship and community engagement**

In a sustainable enterprise workers are valued and their work is organized to conserve and enhance their efficiency and creativity; their security and well-being is a priority; they are encouraged and helped to continually develop their talents and capacities and; their input to and participation in the decision making process is openly accepted. Communities engaged in any stage of the product lifecycle are respected and enhanced economically, socially, culturally and physically. Continued economic viability does not depend on ever-increasing/unsustainable consumption of materials and energy (Sustainable, n.d). Abuse by Chinese firms of their Kenyan employees in the special economic zones is common, namely ‘unfair and restrictive labour practices including low wages, inadequately compensated overtime, sexual harassment, verbal and physical abuse and the violation of the organizational rights of workers’ (Fiott, 2010) as well as poor corporate social responsibility.

Moalosi, Popovic and Hickling-Hudson (2007) underscored that designers need to recognize that people are socio-cultural beings and the process of integrating cultural factors in their practice should be emphasized. Design is firmly embedded in users’ culture. The use of a society’s cultural factors in design not only makes technologies more appropriate for the social context, but makes better use of culture as a resource for innovation. Artifacts communicate cultural values. Hence, the meanings that products

adopt should be constructed in the process of a dialogue between culture, design and users. End-users' interaction with products delivers various benefits at different levels: function, signification, gender, knowledge, aesthetics and mediation (Moalosi et al., 2007). The designers include students, educators and practitioners.

### **Indigenous sustainable practices**

According to Dei (2000) ethnic or indigenous knowledge means knowledge consciousness arising locally and in association with a long-term occupancy of a place. Ethnic also accords a broader identity to local subjects. The author further writes that indigenous knowledge is appropriately discussed within an anti-colonial discursive framework. The approach would recognize the importance of locally produced knowledge emanating from the cultural heritage and histories of peoples, daily human experiences and social interactions. The knowledge is thus personalized, that is, there are no claims of universality. An anti-colonial discursive approach would also point to the relevance of using local languages to create social understandings (Dei, 2000).

Fisher (1987) observes that, African communities have established over time indigenous techniques of preserving their material culture. The people of Zaire and Cameroon stain ivory with a mixture of charcoal, tree sap or pigments from cam wood and oil. The process preserves the ivory, prevents it from cracking and gives it a deep golden brown colour which they prefer.

Indigenous conceptualization of sustainability has the potential to enhance its relevance, yet is excluded from the options of providing possible solutions to emerging pertinent contemporary issues. Mutungi (2016) asserts *okujumbika* (a system of preserving heath and fire for next use) is not only a method of preserving firewood and the environment, but is a means through which families demonstrated care with regard to planning for their needs. Only careless mothers would send their children to fetch fire from neighbours thus expose them to burns. Further, it shows independence, responsibility and sustains peace with neighbours. *Okujumbika* also saves time in collecting firewood because the unused firewood is removed from the fire, rubbed on the ash to extinguish the fire. The one piece

left in the fire is covered in a heap of hot ash to deny it oxygen and used next time. The time saved is used in other productive activities. *Okujumbika* protects the women and girls from attacks of wild animals and unfriendly men they may encounter in the forest. *Okujumbika* is used in food preparation and preservation: roast bananas and cassavas; cook food slowly, keep food warm, keep away insects that would contaminate food. Further, it mitigates energy loss. The wood species used in *okujumbika* are those that burn slowly yet produce a lot of heat namely *obugando* (*acacia hockii*) and *omusheeshe* (*Rhus Natalensis*) (Mutungi, 2016).

Traditionally fire was made by use of two sticks rubbed against each other called *okusinga oburindi*. This technique is environmentally sustainable because the two sticks are selected from the naturally dry tree branches hence no destruction of the living plants. There are several uses for the fireplace in the house: cooking, warming people, education space to pass down knowledge through the generations. In addition, the fireplace in *ishaazi* (place for milking cattle) is for chasing away house flies and mosquitoes and other insects. The fire is made from dry cow dung and wet grass obtained from the cowshed thus produce thick smoke for the purpose (Mutungi, 2016).

Indigenous sustainable practices incorporate appropriate technology (AP) which is both technological innovations and projects. Appropriate technology refers to local people struggling on a daily basis with their needs, understand those needs better than anyone and can therefore suggest or in fact, invent the technological innovations necessary to meet those needs (Troy, n.d). Appropriate technology is also an ideological movement that involves small-scale labour-intensive, energy efficient, environmentally sound, people-centred and locally controlled projects. The approach is a critique to Gross Domestic Product-focused measures of growth and is meant to address four major problems that the latter does not cover; extreme poverty, starvation, unemployment and urban migration. Hence, AP is a sustainable technology, an alternative to technology transfer from developed to developing countries, in that it places both parties on an equal level (Pachamama Alliance, n.d).

## RESEARCH METHODOLOGY

Ethnography research design was employed which enabled the researcher to establish what the social actors had to say (Gobo, 2008), that is, the Mau Ogiek about their indigenous sustainable practices, from their perspective and social-cultural context (Mouton, 2001).

The Mau Ogiek claim the Mau Forest Complex as their ancestral home where they practice their culture. The peoples' hunter-gatherer lifestyle made them settle in forests that were adjacent to plains (Kimaiyo, 2004). The forest is divided into 22 blocks, with the Mau Ogiek inhabiting 12 of these namely, Nessuit, Marioshoni, Saino, Sururu, Kiptungo, Sogoo, Nkaroni, Tinet, Sasimwani, Olt pirik, Nkareta and Olmekenyu (Njoroge, 2010).

The Ogiek peoples' population is 78,691 or 0.20% of the total Kenyan population (KNBS, 2010). The accessible population was drawn from the Ogiek living in the Mau Forest Complex, Nessuit location, inhabited by the highest population of the Ogiek peoples, approximately 2600 people. Further, the Mau Ogiek uphold their culture (Lesingo, personal communication, April 11, 2011).

The point of entry to the Mau Ogiek was the OPDP an organization that champions their rights. Judgement sampling (Mouton, 2001) based on member-identified categories (Hammersley & Atkinson, 1995) was used in the selection of key consultants: knowledgeable about their culture and were willing to divulge it. The sample selected comprised two *intaasatutig* 'elderly women', two elderly *poisionig* 'married men', 20 *rwaganig* 'newly circumcised, unmarried males', 20 *mureret* 'initiated, unmarried females', 20 *tyepoosa* 'married *mureret*' and *intaasatutig* of diverse ages and 20 *poisionig* 'married men of diverse ages' totaling to 84 consultants.

A research assistant-cum-translator was identified and recommended by the OPDP as one who was well versed and fluent in Ogiek, English and Kiswahili and lived in Nessuit location. Data collection employed interviewing, observation and artifact analysis,

resulting in technique triangulation. Interviewing techniques employed key-consultant in-depth interviews and focus group discussions (FGDs). Four key-consultant in-depth interviews were conducted with two *intaasatutig* and two elderly *poisionig* using a semi-structured schedule. Eight FGDs were conducted, each comprising 10 consultants, grouped as, *rwaganig*, *mureret*, combined *tyepoosa* and *intaasatutig* of diverse ages and *poisionig* of various ages. Observation was conducted using photography, because it provides a record that can be analyzed very closely (Flynn & Foster, 2009). The photographs, both posed and unposed show the consultants in their natural settings, wearing their ethnic dress and separately of various cultural artifacts in their homes, in OPDP office and in the Nairobi National Museum collection. Further, the researcher collected and scanned already-existing photographs of the people dressed in their ethnic dress among other items. Any items of the material culture lost over time were sketched.

Artifact analysis (Flynn & Foster, 2009) was conducted on the material culture in their custody, in the Nairobi National Museum and in OPDP office. Only those materials with clearly identifiable dress styles were examined to collect data on the design details and construction techniques. The data obtained from tape recordings of key-consultant in-depth interviews and FGDs were transcribed verbatim and analysed thematically. Qualitative content analysis (Mouton, 2001) was applied on the extant dress and other artifacts and photographs. The data are presented in the form of narratives reported by the researcher, punctuated by corresponding analyses, photographs and sketches.

Consent was sought from the community in writing. The study was thus conducted at the consultants' convenience. The consultants were assured of anonymity and confidentiality, and that the study was strictly for academic purposes.

## **FINDINGS AND DISCUSSION**

### ***Sustainable characteristics of the Mau Ogiek ethnic dress***

The indigenous dress incorporates multiple styles and multiple functions; up-cycle; use natural dyes and cosmetics; no wastage; hand-me-down and consumption of locally available materials.

## Multiple styles

***Leginjus/moloindo*** ‘women’s dress/skirt’

*Leginjus* is women’s beaded leather dress/skirt. The dress/skirt must reach below the calves. *Leginjus* is wide at the top and tapers to a curved V-shape at the hem. The term *leginjus* is derived from the V-shape. Previously, it was constructed from bushbuck skin thus red in colour, which was replaced by sheep skin. *Leginjus* is made of three sheep skins which are stitched together on the wrong side with oversewing stitch using *anwet*. The skins are scraped, dried and softened by rubbing animal fat on them using the hands. The dress/skirt is decorated with glass beads. White, blue, red, green and yellow beads are attached in two rows along the edges and all over the garment in diverse patterns. White beads are predominantly used. The dress is fastened on the left hand shoulder, whereby a strap is laced through a loop and knotted. If leather is not available to construct the dress, an *angeet* ‘*khanga*’ may be worn. Figure 1a and b show dress style of *leginjus*.



**Figure 1a: *Leginjus* bodice style**



**Figure 1b: *Leginjus* bodice style sketch**

**Photo by researcher at Nairobi National Museum**

**Collection dated 1970**

*Leginjus* is also worn as a skirt, by wrapping once around and above the waist, right over

left. A thin *legetiet* is wound twice around the waist and the skin is folded down to cover it. The skirt must reach below the calves. Figure 1c shows the skirt style of *leginjus*.



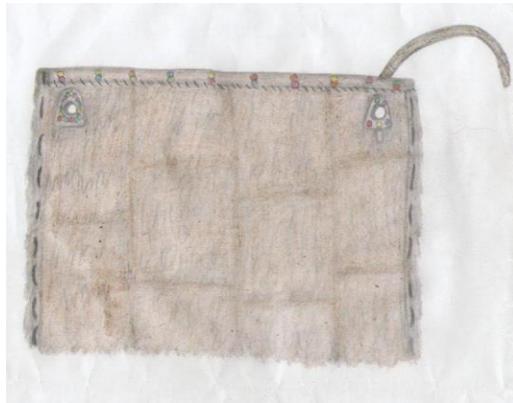
**Figure 1c: *Leginjus* skirt style**

### **Multiple functions**

#### ***Oguriet op inderit* ‘hyrax pelt cloak’**

*Oguriet op inderit* provides warmth to the wearer and a baby carried on the back as well as privacy when a mother is breast-feeding. The cloak is worn by all the members of the community irrespective of gender and age, as it is made to size. *Oguriet op inderit* is approximately 2 ½ m<sup>2</sup> and made of about 18 hyrax pelts which are stitched together on the wrong side with very close oversewing stitches. The raw skin is pegged on the ground to stretch and dry it. The skin is then cut to size and sewn with the tendons of giant forest hogs. A thin leather strip is attached on the neckline, on to which small glass beads of different colours, red, white, blue and green are fixed. The beads are vertically aligned and are fixed at regular intervals. The sides are turned over to the right side and held in place with large running stitches using *anwet*. For fastening, on one side of the neckline, a leather strap is held in place by a small square piece of leather, and small glass beads are strung together and attached on it. On the opposite side a small square piece of leather is attached and a hole is bored through both materials. Small glass beads are strung

together and affixed round the hole. The leather strap is laced through the hole and held by a knot. The *tyepoosa*, *intaasatutig*, *tiet* and *mureret* drape it on the shoulders and fasten it in at the chest, while the *poisionig*, *kecher* and *rwaganig* pass it under the left arm and fasten it on the right hand shoulder. Figure 2a and b show *oguriet op inderit* of 2 1/2m<sup>2</sup>.



**Figure 2a:** *Oguriet op inderit* of 2 1/2m<sup>2</sup>  
1/2m<sup>2</sup> sketch

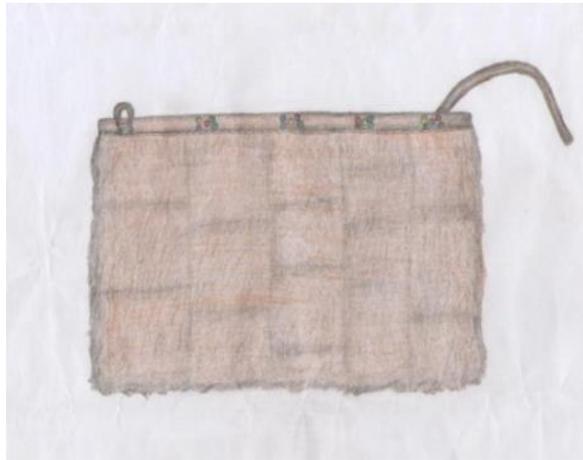
**Figure 2b:** *Oguriet op inderit* of 2

**Photo by researcher at Nairobi National Museum**

**Collection dated 1969**

A larger version of *oguriet op inderit* is made of 33 hyrax pelts sewn together in three rows of 11 pelts each. The length is 48 inches and the width is 81 inches. A leather strip is attached on the neckline on the right side using chain stitch. Four small glass beads arranged in a square and one large one at the centre are attached on the strip at regular intervals. A leather loop is fixed on the right hand side of the neckline and a leather strap is attached on the other end, which is then laced through the loop to fasten it. Figure 2c

and d show *oguriet op inderit* of 48 inches by 81 inches.



**Figure 2c: *Oguriet op inderit* of 48” by 81”  
by 81” sketch**

**Figure 2d: *Oguriet op inderit* of 48”**

**Photo by researcher in Nessuit location**

A baby carried at the back is covered with *oguriet op inderit* that is fastened at the chest. Naiposhi an *intaasat* key-consultant disclosed that when breastfeeding in public, a mother covers the baby with *oguriet op inderit*.

***Annuet op chogeeet* or *annuet rotwetop chok* ‘men’s belt’**

*Annuet op chogeeet* is used to secure *menegupet* in place and suspend *chogeeet*. The belt is made of scraped *poinet* skin strip. Two holes are made on each end. A thin leather strap is laced through one hole, which is fastened through the opposite hole to tie the belt on the waist. The belt must be laced through a loop in a *chogeeet* and tied on the waist. Figure 3

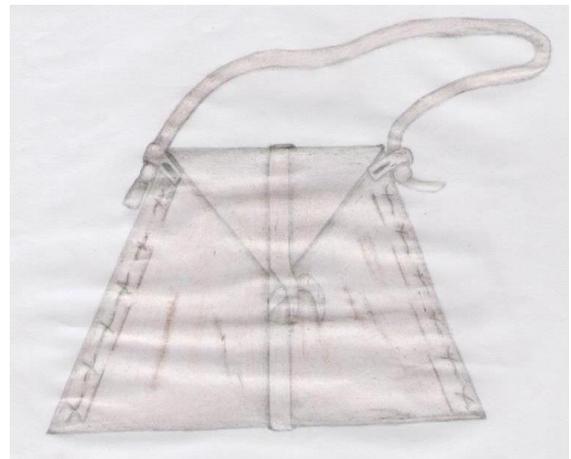
shows *annuet op chogeet*.



**Figure 3: *Annuet op chogeet***

***Motoget* ‘honey bag’**

*Motoget* is mainly used to carry and store harvested as well as for carrying food such as *sirigonig* ‘dried meat’ in case of food scarcity or when one is on a long journey. The elderly people store their small personal belongings in it. Saimutie a *poyoon* key-consultant disclosed that a *motoget* is also used for carrying an indigenous lighter that is employed in honey harvesting. The bag is constructed from scraped hyrax skin. Hyrax provides light and durable skins, thus the bag is appropriate for long travel. *Motoget*, available in varied sizes is wide at the bottom and tapers at the top. The side seams are joined together with running stitches using sinews, and decorated with whipped running stitches. The fastening is a leather strand attached at the tip of the triangular flap, which is passed toward the back, brought to the front and knotted. A shoulder strap is attached to the top sides. Figure 4a and b show *motoget*.



**Figure 4a: *Motoget***

**Photo by researcher in OPDP Nakuru**

**Figure 4b: *Motoget* sketch**

**Up-cycle**

***Mwenigg op itig* ‘women’s earrings’**

The earrings are called *mwenigg* as they are made from leather. The pair of earrings is suspended on the stretched lower earlobes. The earrings are composed of two long narrow strips of scraped bushbuck skin. The strips are folded into half to create the front and back sides. Glass beads of different colours are attached along the edges of both the front side and back side. Additional beads in horizontal patterns are fixed on the former. The two earrings are held together by a strand of glass beads attached to the tips which extends to the chest. To don it the earring is opened out, the underside is inserted in the earlobe and the two sides clasp together. The earrings are basically flap earrings. Figure 5a, b and c show *mwenigg op itig*.



**Figure 5a: Woman wearing *mwenigg op itig***

**Photo by researcher in Nessuit location**



**Figure 5b: *Mwenigg op itig* front view sketch  
back view sketch**



**Figure 5c: *Mwenigg op itig***

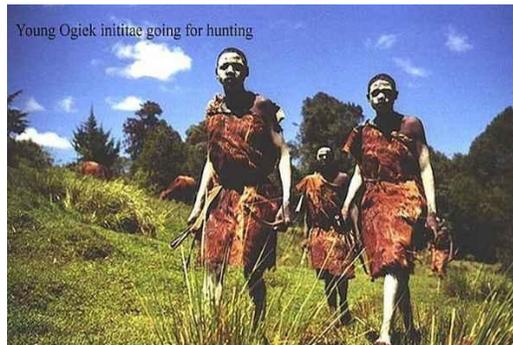
**Use natural dyes and cosmetics**

The *rwaganig* FGDs disclosed that they dye leather cloaks with red ochre.

The *tyepoosa* and *intaasatutig* FGDs reported that the females prepare cosmetics such as *oweyet* ‘jelly, produced from animal fat specifically bushbuck, rhino and buffalo’ for

themselves and their families. During a *goito* ‘wedding ceremony’ the bride’s mother applies *oweyet* on the groom’s forehead to symbolize that he has been given the bride. Further, all the groom’s family members irrespective of age are also applied *oweyet* to symbolize that they have been joined to the bride in matrimony.

*Tuoreg* ‘boy-initiates’ smear *induroit* ‘white clay soil paste’ all over their bodies to hide their identity. *Induroit* thus identifies the setting as *tumdo op werik* ‘. Figure 6 shows application of *induroit*.



**Figure 6: Boy-initiates smeared with *induroit***

**Photo from OPDP website**

### **No wastage**

All the parts of a slaughtered animal are used to construct diverse articles of dress.

### ***Rosiet* ‘headdress’**

*Rosiet* is a general term for various styles of hats or headgear. The headdresses are made from different materials such as hyrax pelt, cow’s innards and cardboard. Children wear undecorated, cone-shaped hyrax pelt hats. The hat is made to fit the wearer’s head. Figure 7a and b show children’s *rosiet*.



**Figure 7a: Children in *rosiet* children**

**Photo courtesy of OPDP Nakuru**



**Figure 7b: *Rosiet* for children**

Men's hats are made of cow's innards. In construction the innard is cleaned, dressed onto the underside of a medium size clay pot and allowed to dry thus, taking its circular shape which fits the head. Men's headgear is also made from hyrax or colobus monkey or baboon pelts and it resembles a wig. Figure 7c shows men's *rosiet*.



**Figure 7c: *Rosiet* for men**

### **Hand-me-down**

***Taet*** ‘brass bracelet/necklace’

The brass bracelet is worn on the right hand. A son may also inherit a *taet* ‘brass bracelet’ from the father. The finding concurs with Ademuleya (2011) who found out that as *aso-oke* can be inherited. Naiposhi further disclosed that no article of the Mau Ogiek’s indigenous dress is ever thrown away, an economic value. If one outgrows a bracelet, a new one is constructed and worn, and the old one is kept away for future use. Figure 8a and b show *taet* ‘brass bracelet’.



**Figure 8a: *Taet* ‘bracelet’**

**Figure 8b: *Taet* ‘bracelet’ sketch**

**Use locally available materials**

***Pirir orog*** ‘necklace’

*Pirir orog* is made by stringing together small red pieces of wood which are cut from the stem of a tree called *pirir*. The necklace is donned on new born babies. Figure 9 shows *pirir orog*.



**Figure 9: *Pirir orog***

***Nguloleit*** ‘disc’

*Nguloleit* is a round wooden disc cut from a tree called *iguloleisieg*. The disc is made in diverse sizes and worn on the pierced lower earlobes to enlarge and stretch the holes. Figure 10a and b show *nguloleit* and *gempirr itig* ‘ear piercing’.



**Figure 10a: *Nguloleit***



**Figure 10 b: *Gempirr itig***

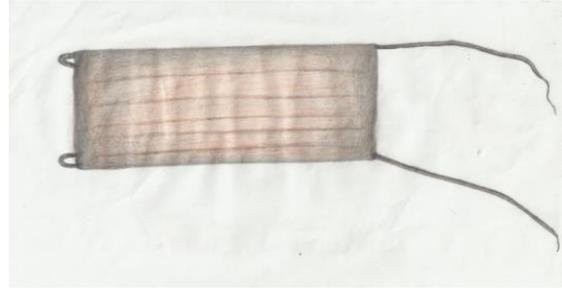
***Gesenta*** ‘baby carrier’

*Gesenta* is constructed from scraped and softened bushbuck skin so as to provide comfort to the baby. The carrier is fastened at the waist and on the left shoulder by passing leather

straps through loops and knotting them. Figure 11 shows *gesenta*.



**Figure 11a: Baby being carried in *gesenta***  
**Daily Nation January 12, 2016**



**Figure 11b: *Gesenta* sketch**

### ***Entrepreneurship and community engagement***

The *tyepoosa* and *intaasatutig* FGDs reported that the people can construct any item of their ethnic dress on order for sale. Thus, the dress takes a commercial aspect. Midwifery is carried out by *tyemosianisieg*, an elderly woman and is highly remunerated. The remuneration conforms to a sustainable enterprise where workers are valued among other commitments (Sustainable, n.d). The community asks for payment to provide information about their culture, such as dress. The Mau Ogiek exhibit their material culture, which includes their ethnic dress at the various Agricultural Society of Kenya shows. Further, they welcome anyone who wishes to study their ethnic dress to their habitat. The studies add to the body of knowledge on culture. The Ogiek Cultural Centre in Marioshoni, Molo Constituency was officially opened in June 2015 (Correspondent, 2015). Through the cultural centre fashion designers may work closely with the community to incorporate the Mau Ogiek's ethnic dress in their collections, for instance, the *motoget* and *mwenigg op itig* among others thereby preserving the culture. Hence, as Moalosi et al. (2007) assert that designers become creators of cultural experiences that enrich fundamental human experiences of being alive. The effort supports *SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*.

### ***Sustainable peaceful co-existence***

To sustain peace within and without the community the Mau Ogiek offer cultural service to and trade with neighbouring communities, borrow from other cultures, engage in

cultural authentication, fix beehives in one's territory and ensure equitable resource allocation and consumption.

### **Offer cultural service**

Saimutie, an elderly *poyoon* key-consultant reported that the Mau Ogiek's circumcisers are sometimes called upon to circumcise young Maasai boys for pay. The payment is in the form of sheep whose skin is used to fabricate their indigenous dress.

### **Borrow from other cultures**

The Mau Ogiek borrowed artifacts from the Kipsigis *gelteet and chepkuleit* 'headdress' and *rungut op metit* 'club'. Borrowing clearly indicates appreciation of another community's culture.

### ***Gelteet and chepkuleit***

*Gelteet and chepkuleit* was worn by girl-initiates to the night dance on the eve of FGM. *Gelteet* is made of cardboard that is shaped as two pairs of elephant tusks turned on each other. Other styles include bird figures. *Gelteet* is worn on the face, secured by a strip of bicycle tube and a bicycle light bulb, contemporary shiny garlands and small plastic lids of various colours are fixed on it. Figure 12d, e and f show different styles of *gelteet*.



**Figure 12d: *Gelteet* style (A)**

**sketch**



**Figure 12e: *Gelteet* style (A)**

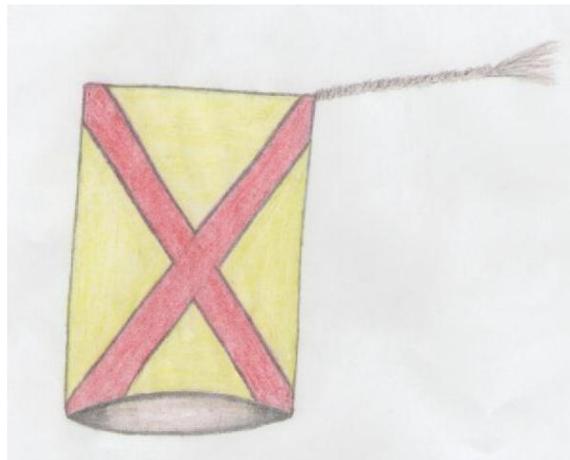
Photo by researcher in OPDP Nakuru



**Figure 12f: *Gelteet* style (B)**

Photo by researcher in Nessuit location

*Chepkuleit* is a rectangular two-piece fabric hat which is worn underneath a *gelteet*. One side may be yellow and the other white. Black or any colour of fabric strips are attached on the front side in an X-pattern, in addition to shiny garlands. Knitting yarns are plaited leaving loose threads at the tip. The yarn is then attached at one tip of the hat. The hat is stiffened, supported and made firm on the inside by two sticks held in an X-pattern. Figure 12g shows *chepkuleit*.



**Figure 12g: *Chepkuleit***

***Rungut op metit*** ‘club’

The Kipsigis introduced *rungut op metit* to the Mau Ogiek during joint initiation of boys. The club is mainly constructed from *mūtamaiyũ* tree, in addition to *mũnderitũ* and *mũcharagĩ* trees. There are two types, for the *rwaganig* and *girwogindet*. For the former, the tip is round, thus the term *metit* ‘head’, bent downward and it is cut in one with the handle. Figure 13a and b show *rungut op metit* for the *rwaganig*.



**Figure 13a: *Rungut op metit* for *rwaganig* sketch**

**Photo by researcher at Nairobi National Museum**

**Collection dated 1970**



**Figure 13b: *Rungut op metit***

The *girwogindet*'sclub also has a round tip cut in one with the handle and incisions are made on the handle. Figure 13c shows *mukwanjit* for a *girwogindet*.



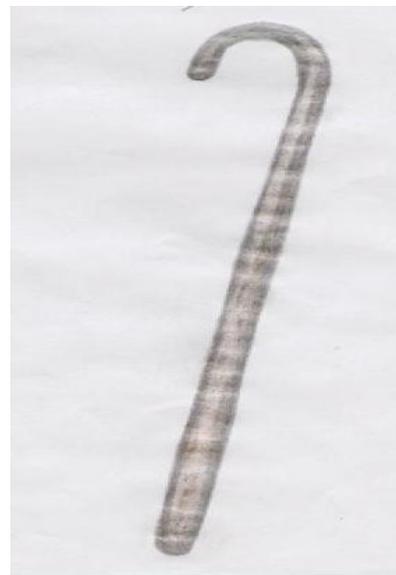
**Figure 13c: *Rungut op metit forgirwogindet***

### **Cultural Authentication**

The *rwaganig* FGDs disclosed that the Mau Ogiek boys may join the Kipsigis' boys for initiation, and they follow the rituals of the latter. Thus, the Kipsigis' walking stick has been culturally authenticated by the Mau Ogiek and named *mukwanjit*. *Mukwanjitis* obtained from a young tree branch which is bent at one tip, left to dry and acquires the curved shape of a walking stick. Figure 14a and b show different styles of *mukwanjit*.



**Figure 14a: *Mukwanjit* style (A)**



**Figure 14b: *Mukwanjit* style**

**(B)**

The Maasai *shuka* is given to the *rwaganig* during their graduation ceremony. The *rwaganig* fasten it as they do *oguriet op inderit*, that is, under the left underarm and on the right shoulder.

### **Fix beehives in one's territory**

Each male member of a household fixes *mweingonig* 'beehives' in the *gap* 'clan' territory to which one belongs. *Mweingonig* are the people's "cattle" or wealth which are exclusively constructed and owned by the men. Indigenous *mweingonig* are constructed specifically from mature *septet*, thus they are red in colour. The key-consultants reported that for a *rwaganto* to be eligible for marriage, one must have a minimum of ten *mweingonig*. The requirement assures the community that he can feed his family. However, some *rwaganig* are lazy thus they take a long time to acquire the requisite *mweingonig*, hence they delay in marrying.

### **Equitable resource allocation and consumption**

Kiplangat (2009), states that the forest is divided into *gap* and each has exclusive rights over it. Land rights include rights to hunting grounds, to fix beehives and to collect honey and natural materials, such as trees and bark for manufacturing of ethnic dress. The forest is further sub-divided for family units. The men only hunted in their own clan's territory. The rules were so strict that in the event of an animal such as *poinet* being hunted ran into another clan's territory the hunters were not allowed to pursue it farther. Instead, they reported the matter to the concerned clan, and it tracked it down and handed it over to the hunters. The rules ensured equitable resource allocation and use, for instance, the availability of animal skins to construct the dress, and to prevent clan conflicts.

### **Trade with neighbouring communities**

The interaction of the Mau Ogiek with the neighbouring communities through trade brought about sustainable peaceful co-existence. Serere an *intaasat* key-consultant reported that they engaged in barter trade whereby the Mau Ogiek women exchanged among other items *teret op menet*, *teret op gomek* and serving spoons which are used to scoop honey from containers for *angeet* and cotton fabric with the early Christians. The

Mau Ogiek sold to Kikuyu community *teret op menet* and obtained *segereg* ‘cowries’ used in embellishing *oguriet op saamput* and constructing *segeriet* ‘cowries bracelet’, adorn *oguriet op saamput* and pendants.

The *poisionig* FGDs reported that the people also engaged in barter trade with the Maasai, where *gomek* was exchanged for sheep, red ochre, metal, brass, glass beads, milk and tobacco. The sheep skin was used to make *leginjus*. Brass is used to fashion *ilmintoisieg* ‘men’s earrings’. Glass beads of diverse colours are used to fabricate and embellish *kauya* ‘leather skirt’, *mwenigg op itig*, *ingongonoit* ‘headband cum necklace’, *ingarepait* ‘brides’ necklace’, *ingotiot* ‘flywhisk’, *leginjus* and pendants. In addition, the community exchanged ivory and black monkey skin for a calf. The calf was consumed and provided skin for constructing *menegupet* ‘men’s vest’. Further, *oguriet op saamput* ‘baboon pelt cloak’ was exchanged for oxen, as the Mau Ogiek never reared these. Rather, they ate them and used the skin to construct *kweog* ‘men’s sandals’ and *legetiet* ‘women’s leather belt’ and men’s *rosiet* from cows’ innards. Previously, *kweog* and *legetiet* were made of bushbuck skin, while *rosiet* were constructed from hyrax and bushbuck pelts. Later however, they adopted livestock rearing, which influenced the dress in diverse ways. The results concur with Mann (2011) who established that Europe engaged in a highly lucrative trade with Africa, exchanging glass beads for such items as ivory, gold and incense. Many of these trade beads became part of costume and adornment among Africans. Dark pink Venetian glass beads dating back to 1830 found their way to the Samburu, while blue annular beads are still worn by Borana elders. SDG 16: Promote peaceful and inclusive societies for sustainable development. Figure 15, 16, 17, 18, 19a and b and 20 show different styles of



**Figure 15: *Ilmintoisieg*  
holding *ngotiot***

**Figure 16: *Ingarepait***

**Figure 17: Woman**

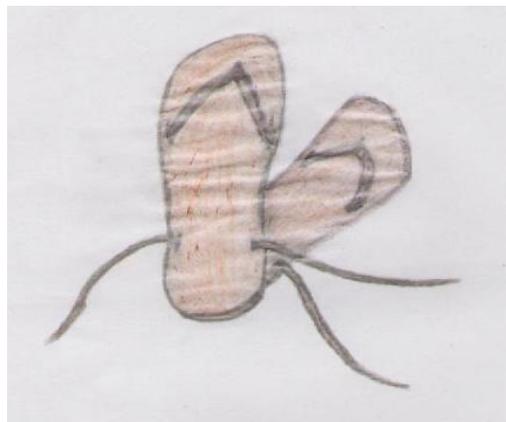
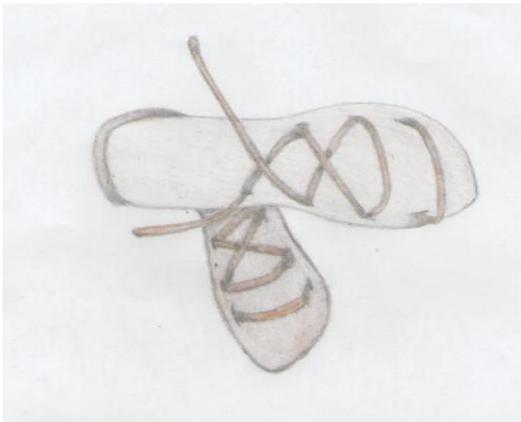
**Photo by researcher in Nessuit**

location



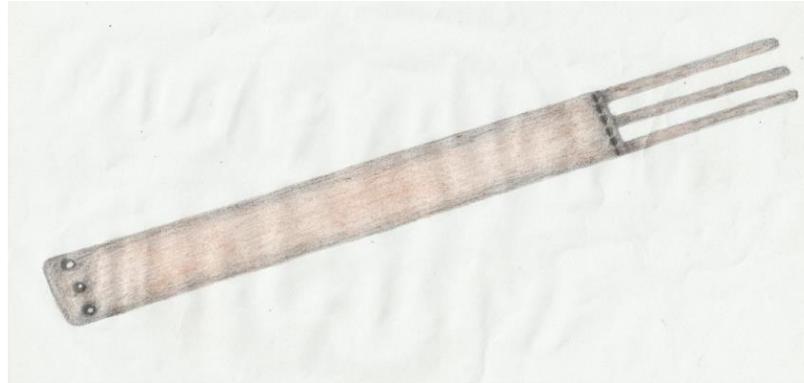
Figure 18: Man wearing *menegupet* and *oguriet op nderit*

Photo courtesy of Simon of Nessuit location, taken in 1957



**Figure 19a: Kweog style (A)**

**Figure 19b: Kweog style (B)**



**Figure 20: Legetiet**

### ***Food security***

Owning many beehives and storing honey ensures a family's and neighbours' food security they were very concerned about each other's welfare. The men also fabricate *gisungut* 'storage container for honey'. The stored *gomek* is only used when they fail to get any in the forest, for instance, in times of heavy rain, or when it is not the season for honey. The *tyepoosa* and *intaasatutig* FGDs disclosed that the women collect edible wild fruits, fetch water and firewood, cook, and raise the children. The women construct *lekwelet* 'storage container for dried meat' which ensures a family's food security, as *sirigonig* 'dried meat' never rots and is only consumed when the men fail to get any game meat in their hunting expedition. The indigenous sustainable practices conform to *SDG2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture*.

### ***Environmental management***

#### **Harvest honey sustainably**

Honey harvesting is done seasonally thus sustainable. The *rwaganig* and *poisionig* FGDs reported that some movements by the Mau Ogiek were for socio-economic reasons. In the olden days, movement was seasonal in search of flowers that attracted bees and the bees producing honey in return which was harvested by honey harvesters donned in

prescribed dress. In the lower area of Nakuru, flowers blossomed faster and there was plenty of food compared to the higher ground of Mau Forest Complex. The flowers first blossomed in the lower region.

### **Sacred trees**

Kiplangat (2009) asserts that the forest provides spiritual sites, sacred trees and *peeg op tegeldit* 'pure fresh water'. Trees were so sacred to the community that they could not be felled at random. If one needed a tree, he/she was required to seek permission from the elders with a very valid reason. Felling a tree without permission was thus an abomination to the community. Unless one is cleansed through some rituals performed by the elders wearing specific ethnic dress, then the culprit stands a high chance of "falling" (dying) or sickness or being bound to live a very miserable life. The violation may also occasion famine and drought to the community. Rites of passage are performed in the forest namely *tumdo op werik* 'boys' initiation ceremony' in which the *torusieg* 'initiates' and *mutiriot* 'teacher' must don the prescribed dress. The finding supports Maathai (2006) assertion that the Kikuyu community's cultural and spiritual reverence for the *mugumo* 'fig tree' contributed to the conservation of biodiversity. The Gikuyu prayed under a holy *mugumo*. Maathai decries the destruction of the natural ecosystem by the traders and administrators during the colonial period who replaced indigenous tree species with exotic ones and engaged in commercial agriculture. Over the decades rivers and streams either dried up or were greatly reduced. The results also ensure attainment of *SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystem, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss.*

### **Meritocracy**

Meritocracy was observed in political organization whereby Saimutie a *poymoon* key-consultant disclosed that before colonialism, the Mau Ogiek had diffused authority, devoid of centralized authority which normally has such roles as those of chiefs or formal council of elders. The finding is similar to that of Olaoba (2005) and Edo (2005) who state that indigenous political systems in Africa are societies with diffused political

leadership, as the peoples were preoccupied with hunting, food gathering or animal husbandry. For instance, the Logoli, Igbo, Tallensi and Nusr people of Nigeria. The *rwaganig* FGDs reported that when community matters arose, such as family or *gap* conflicts needed to be resolved, a *girwogindet* ‘indigenous volunteer leader’ assisted by other elders would undertake the task. The *girwogindet* wore special dress for identity. One qualified to be a *girwogindet* if he was brave and an expert hunter: qualities reflected by having killed fierce animals such as a buffalo. The *girwogindet* had married off his daughters, initiated almost all his children and was left at home with his wife. Further, one must possess many *mweingonig* as people went to him for help and naturally he provided assistance. The results agree with Edo (2005) who established that power was vested in people of virtuous and proven integrity as well as titled men. In addition, personal attainment in wealth, war, physical or magical power won the respect of others.

The *tyepoosa* and *intaasatutig* FGDs revealed that during the colonial era, the position of a headman was created among the people. The headman linked the community and the government. A male member of the community volunteered his service, but he had to be vetted and accepted by the community. The colonialists were obliged to accept the group’s choice. The council of elders, composed of both men and women, is a recent phenomenon, which came about due to the establishment of the Mau Forest Complex taskforce in 2009. The members do not have any prescribed ethnic dress. To qualify to join the council one has to be old, respected by the community, a community mobilizer and to have raised one’s children well according to the community’s values. The council is tasked with matters of land, especially on evictions from and excision of the Mau Forest Complex by the government, and to settle *gap* and family disputes. The councils composition helps attain *SDG 5: Achieve gender equality and empower all women and girls*. The community is also governed by the national government officers- chief and sub-chief, who perform administrative duties. Given their ethnic minority status, the community has been unable to elect one of their own to politics. Consequently, their cultural rights are not effectively championed.

The *rwaganig* and *poisionig* FGDs reported that the community’s security is provided by the *rwaganig* as the community faces attacks mainly from the Laikipia and Maasai. The

*rwaganig* also provide security from wild animals and have to don prescribed dress. The result concurs with that of Edo (2005) who established that age-grades were empowered by the community to carry out seemingly difficult tasks in warfare, public work and other social callings.

### ***Gender equality***

Mutarakwa and Serere respectively elderly *poyoon* and *intaasat* reported that the existence of cultural experts played a great role in the dress. These experts are very knowledgeable on the group's cultural issues, both material and non-material culture. The elderly women and men and other members of the community with a high level of ethnic identity, were called upon to either instruct on the construction of dress or fabricate it. The dress had to be made according to the non-material culture tenets, such as normative order for dress and clothing customs. Hence, the community implements *SDG 5*.

The men were responsible for the organization of diverse cultural occasions and their accompanying ethnic dress. The boys' and girls' rites of passage were strongly upheld in their totality and accompanying dress. The community, however, was gender sensitive hence it included women in decision making to some extent. The women, therefore, had a say in the matters concerning the indigenous dress. Gender integration occurs in the construction of *morogit* 'quiver' which is done by both elderly *poisionig* and *intaasatutig*. The findings concur with Ng'ang'a (2006) who established that the male elders with advice from their wives made decisions on community matters, such as the next move in search of raw materials for dress. In essence, the Mau Ogiek implements *SDG 5*.

### ***Appropriate technology***

Metal obtained through barter trade with the Maasai was used for constructing tools for fabricating dress, such as *gisienjot* 'indigenous chisel' and *ayuet op kusiet* 'hide scraper'. The former is used to fabricate *nguloleit* and *rungut op metit* and the latter to makes hides and skins soft and pliable. Figure 21a and 1b illustrate respectively *gisienjot* and *ayuet op kusiet*.



**Figure 21a: *Gisienjot* and *gungit*.**

*kusiet*

**Photo by researcher in Nessuit location**



**Figure 21b: *Ayuet op***

**Photo by researcher at Nairobi National Museum Collection dated 1969**

The *poisionig* FGDs also reported that other tools include *impiniit* ‘indigenous awl’ which is employed for patching together pieces of animal skin to construct *oguriet op inderit* and *chogeet* and to attach embellishment for instance, beads on *mwenigg op itig* and *segereg* on *oguriet op saamput*. Indigenous *rotwet* ‘knives’ were constructed and used to cut the animal skins into the required pieces and yarns. *Mecheita* ‘thin metal rod with a wooden handle’ is used for boring holes in wood in the construction of *pirir orog*, *ingerut* ‘arrow’ and *tenget* ‘spear’. The finding concurs with Troy (n.d) that appropriate technology refers to local people struggling on a daily basis with their needs, understand

those needs better than anyone and invent the technological innovations necessary to meet those needs.

## **CONCLUSION**

The Mau Ogiek have employed indigenous sustainable practices since time immemorial. Based on the findings, it is clear that Afrikan indigenous sustainable practices have a profound role to play in achieving the *SDGs* and in Kenya's context the national development visions and policies particularly in sustainable fashion design; entrepreneurship and community engagement; sustainable peaceful co-existence; food security; environment management; meritocracy; gender equality and appropriate technology. These practices if adopted with the communities' engagement shall lead to Afrika's transformative development and sustainable livelihoods, as well as decolonizing Afrikans while complementing existing globalization.

## **RECOMMENDATIONS**

Based on the discussion this paper recommends,

- i. Higher education institutions (HEIs) to incorporate Afrikan indigenous sustainable practices in academic programmes to foster deeper understanding, exploration and application in the contemporary setting while providing appropriate solutions to emerging issues. The solutions could be innovative products and services consciously inspired by the users' socio-cultural practices.
- ii. Recognition and engagement of indigenous communities in the adoption and application of their sustainable practices to include their knowledge, perception, beliefs and attitudes among other in order to achieve transformative development and sustainable livelihoods.
- iii. Although this study has provided a scan of indigenous sustainable practices of the Mau Ogiek, more research needs to be conducted to uncover other sustainable strategies and possible implementation routes to achieving glocalization.

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# **Culture, Peace and Development: The Case Study of West Pokot County, Kenya**

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## **ABSTRACT**

Violent conflict has been experienced in West Pokot County for decades. This county is the home of pastoral communities whose livelihood entirely depended on a cow for centuries. As such, conflicts in this region rotated around a cow. This study interrogated extent to which cultural practices have contributed to peace and development of the region. The study applied case study design situated within the qualitative tradition. Women, men, youth, NGOs officials, and representative from all levels of governments provided information. The study found that cultural practices such as songs encouraged conflict and peace in the one hand. On the other, some aspects of cultural practices have sustained lives and promoted growth of prosperity of people. The study recommended that the government, nongovernmental organizations and the community to initiate regular dialogue meetings, peace tours, cultural events and sports for peace to create more awareness on peace, benefits of peace, and increase levels of interactions among the warring communities in a bid to spur social-economic development of people.

**Key words:** Culture, Peace, Development, West Pokot, Kenya

## **Introduction**

This study focused on how cultural practices such as songs could promote peace, conflicts or spur growth of prosperity. The following sections were covered: the background to the study, theoretical framework, materials and methods, findings and then conclusion and recommendations.

## **Background to the study**

Culture, taken in a broader sense, is the way of life of a people. It includes socially acquired knowledge, beliefs, art, law, morals, customs, and habits. It influences the people's lives, activities and behavior towards others (Nganga, 2012). The idea of culture introduces the notion of shared meanings and values, and diversity between different peoples of the world. It also creates a space for thinking of peace as the province not just

of politicians and soldiers but also of ordinary people (Damirchi, Hazrati and Poushaneh, 2013). War is deeply rooted in people's culture; the spirit of war is embedded within literature, poetry, rewritten history, media, language and widescreen movies; all these tend to offer-glorify wars and as a result inflame the imagination of youth (Zamir, 2005). However, some traditions are undoubtedly time-proven and of lasting value, but others have become obsolete and sometimes also ethically objectionable (Malan, 2005).

Werner (2010) has argued that culture can provide peace workers with a context as well as a resource for potential conflict resolution activities. The context informs about values, meanings, as well as community practices and allows one to see and make sense of the world through the eyes of the locals. As a resource, culture guides certain activities and may provide tools for responding to new situations, as it remains fluid and flexible, rather than static. International peacebuilding practitioners and their local counterparts should primarily learn from each other, proposing concepts that take into account the traditions and lives of the local community so they can avoid imposing alien cultural change, no matter how desirable or seemingly natural. Conflicts particularly among the pastoral communities are embedded in people's culture; even local proponents of peace have unconsciously supported structures that sustain conflicts. This is to say, if at all we have to succeed in achieving peace, we should examine those cultural elements that sustain persistent conflict as we replace them with those that promote peace and inclusive prosperity of people, and reinforce those aspects that have propped up the ideals of peace and social cohesion. It is against this backdrop the study interrogated how songs as a cultural practice have contributed to peace and shared prosperity among the Pokot people.

### **Context and Nature of Conflicts**

West Pokot County is among the counties in the North Rift region of Kenya. The region is a vast arid and semi-arid with experiences of frequent droughts. It is settled by pastoralist nomadic people such as Pokot, Turkana, Samburu, Borana, Rendile, and so on. These people move from one area to another in search of water and pasture for their livestock as away to buffer the impacts of drought such as loss of livestock, malnutrition, rise in the cost of living, high poverty levels and loss of lives. Their movements are not restricted to one area or even country. They move into and out of the neighboring

countries such as Somalia, Ethiopia, Sudan and Uganda. These movements are one of the major sources of misunderstanding and conflict between them and their neighbors (Nganga, 2012). The author adds that the vastness and remoteness of the area, inadequate road networks, hilly terrain, and scarcity of resources goes hand in hand with lapses in security occasioning frequent misunderstanding and violent conflicts among these pastoral people.

## **Theoretical Framework**

### **Lederach Conflict Transformation Model**

In 1997, John Paul Lederach offered his seminal work on conflict transformation theory. The theory views peace as centered and rooted in the quality of relationships. This includes both face-to-face interactions and the ways in which we structure our social, political, economic, and cultural relationships. Lederach stated the key dimensions of peace process as the changes in the personal, structural, relational and cultural aspects of conflict, brought about over different time-periods (short-, mid- and long-term) and affecting different system levels at different times (Miall, 2004, Paffenholz, 2009). We found this theory salient to inform this study.

### **Materials and Methods**

The researcher used the case study design situated within the qualitative research tradition. The choice for this design was appropriate because it enabled the researcher to collect rich and in-depth data on violent conflict and development in Pokot. Focus group discussions, interviews, observation helped to collect data from elders, leaders, men, women and youth from West Pokot County. The data was analyzed applying content analysis technique. This technique, helps researchers to organize material systematically guided by two approaches namely, simple mechanical word counts and broad-gauged interpretations of themes (Druckman, 2005).

### **Findings**

Songs have been very powerful tool of communication in oral literature and in diverse infinite communities of the world. They expressed people's deep emotions and core feelings. People sang when they were happy, in celebrations, while mourning, provoking attention, entertainment, while working or as a source of livelihood. The study revealed that among the Pokot people singing, composing songs and dancing were highly valued

cultural activities. Songs were very attractive, enlightening and enhanced people's attention as they received the message. Different songs were sung in different occasions: Songs praising successful warriors; songs ridiculing losers, singing as a way of speaking and songs promoting peace. In other words, one of the women commented that different songs had different content, for example, if it were a raiding song, it gave morale to raid as well as aroused the hearts of men to be aggressive. And so if it were a peace song, it highlighted incalculable benefits of peace or demerits of violent conflict; and if it were song about lazy people, it gave illustrations of remarkable or extraordinary and hardworking people in the community. Thus, the value of the song depended on who was singing? What was the content of the song? Why one was singing and to whom? As one youth puts it succinctly:

*Songs plays a central role in any activity...when one is ploughing alone s/he needs an accompaniment, when there is pumper harvest there is a song, when appreciating the beauty of nature there is a song...even in the activity of CR they used songs to praise heroes. From the song you will know who the hero is or who lost...it has been the responsibility of women to sing as they ululate. Songs motivated hardworking people, hardworking leaders who had brought development and so forth. Some songs have also mocked those who had done evil in the society. For example, if the community disliked certain set of behaviours in a person, they pointed that in a song to discourage such behaviours.*

An elder made an insightful remark:

*Songs can bring conflict, peace and development. If raiders attempted to take your animals and women sang for the strong men to keep them at bay, they will always do so. If peace songs were sang, they brought peace in people's hearts, mind and soul. In short, if a song had a version of hatred, it promoted hatred. If a version of peace, it promoted peace. If a version of development, it promoted development.*

As outlined above, singing in Pokot is a way of speaking. Elders passed very important or crucial communications in form of a song without demeaning either part. For instance, one of young women whom I interviewed provided an illustration of a young man who was arrested. He was being grilled by security officers with regard to some of the cultural practices alleged to have been offensive. One of an elder in that meeting began a song

informing the young man not to disclose any information about their community, instead the elder asked the young man to die like a man. The next levels we are going to present the findings on how songs have promoted peace and protracted conflicts among the Pokot people. We shall also interrogate whether songs were related to growth of prosperity among the people.

#### Songs and Violent Conflict

The results revealed that in Pokot songs were used to inspire and provoke warriors to launch raids. The findings from the questionnaire revealed that songs that have praised owning of animals have profoundly catalyzed the practice of CR. Such songs were commonly sung by women encouraging men to be more courageous as they kept protecting the community. They reminded men that CR was part of their lives; they should be fearless unlike women. Women also remind men that they were like those other men from other communities. As an elder enthused, when the sun rises, it arose with great hope. Women's songs praised the brave men and created the awareness that the community depended entirely on them, "The strong men and boys were told you are the security of the community. Your fathers and mothers are growing old. Where are you boys, where are you men? Why are our cows gone? Where were you? Were you sleeping? Are you cowards? Are you still men or you have turned to be the women of the other community?" These songs were usually sung in the presence of men. Then men could reply, "We have heard you." They could regroup thus, to plan for the raid in order to please their women. In that connection, the women were expected to prepare strong meals rich in protein such as boiled beans and maize plus tobacco for those who smoked in preparation for the long journey. The food was ferried by the young boys who were regarded as store men, they were all well guarded. In every raiding group, some of the skilled warriors were always in front and others behind. Those in the middle were expected to drive the animals or newly acquired wealth.

The research found that some of the songs performed by women were praising the courageous men on one hand, and on the other, humiliating failures. This has activated the culture of violence. For example, *Orwantee kotanyenyee wayee* translated as I sleep in a home where there is a cow. The song meant that even if the cow has made men to die, the woman could only sleep a home where there was a cow. Such songs instilled fear

in men that without a cow, they would miss to have women. They provoked men to engage in violent raids to acquire more animals. Moreover, the women could sing while ululating and praising their sons and clans. They smeared their successful sons with oil as a strong sense of family security. One of the women could be heard singing:

<i>Keruwecha chepotupon</i>	we drink sour milk
<i>Kemitecha kalya</i>	we live with peace
<i>Ke sala werpo murron</i>	praise the strong men

This song suggests that if it were not the strong men, the warriors the community could not be at peace. They protected the community from its perceived enemies; and brought cows that were the source of milk and meat, basic and salient food for pastoralist communities. The song encouraged CR as the surest strategy to earn livelihood. For those men who had unsuccessful to engage in violent raids were condemned and equated as women. This has equally given them impetus to organize scores of raids in a bid to earn respect and fame.

A successful warrior or hero could compose and perform a song demonstrating the challenges experienced in a raid and how they were overcome. He could mention places where he passed: I went to Karimojong, Sabiny and brought a cow. I crossed such and such a river, navigated such and such a mountain, shot down several men and he could mention the strong men who had rendered him an helping hand. A woman commented: “A warrior could compose a song about the person he had killed. Then he could pose: Who is here? I am a bull.” The warrior could then praise the bull and demean the person he had killed or stolen his animals. He equated the person with a fly eaten by maggots, to imply that the person was down or disabled or insignificant. Another warrior could sing a scaring song that, “A cow at a place A in Pokot, during the day is looked after by my sisters. If you want to come, come during the day. During the night the cow is guarded by the four armed strong men, facing different directions, if you want to come it’s for your own peril.” The study also found that the goads to compose and sing a hero song motivated strong men to raid and kill. One of the young men reported in a FGD: “One group was going Turkana for a raid, the attacked failed. One guy in the group who aimed to go and kill cried: Can I sing my song without mentioning the person I had killed. I can’t go home. Because of that five of them were compelled to continue to another

location in a bid to launch another attack. They found people in a bore hole and killed them.”

A famous man, moreover, Lokoumosor could be heard singing: *Lokoumosor keuyono? Oluwan too nowasha, Kichogh nyobo lokonkona kuchogh lo! Lodua!* Translated as warriors where have you slept? Is it in the bush? Doo, the sound of the gun was heard. The song informed that the sound of Lokoumosor’s gun was a tough one. Meaning that men earned more respect when they engaged more raids than the others. These songs accelerated men to launch frequent and tough raids.

Some of the songs sang during *sapana* were said to be emotive as well as encouraged the culture of violence. They challenged warriors to defend their people. They encouraged them to fight their perceived enemies. The warriors were seen with weapons to show their prowess as they connected with the rhythm of the song, “It was an international game...when the song mentioned some words you could hear the sound of the gun,” commented one of the elders. The men who were singing were observed to be trembling as they expressed their inner feelings. It showed that songs can penetrate deeper into the core of a person than other channels as the message was delivered as it is. One of the MCAs I interviewed revealed that some of *sapana* songs could interrogate to find how warriors fared on economically. They challenging them to regroup and go for raids or to graze in a neighbour’s field, “...regroup and go and get something or go to graze the land which does not belong to you.” The songs motivated men to show that they were men through raids. The man with one woman was mocked to add another one. He was asked to go Karimojong and get cows for the dowry. The moment a warrior attempted a raid; women sang ululating as they informed him that he was no longer a puppet. These encouraged others to go for raids as one elder amplified: “Songs motivated a man to show his manhood...the moment he staged successful raid women sang ululating. The message of the song informed him that now you are not a puppet... you were nobody now you are somebody. This encouraged others to go for raids.” Other songs praised the initiates informing them how great they had made their family, in particular, and the community at large, they provoked men to keep at bay their enemies as aptly put by a young woman, “songs informed him how he made the family and the community to appear.”

As the study had revealed earlier, women were instrumental in raiding process. A Pokot warrior planning to go for a raid can be heard singing the following song to prompt women to wear *lokoty*, the belt with magic powers to protect him:

Oh! Chepomoi ooh! Chepomoi Chepomoi	oh! Lady Chepomoi ooh! Lady
Ohoo! Chepomoi <i>kirir</i>	ohoo! Lady Chepomoi crying
Chepomoi <i>amadawa ahaya</i> belt	Lady chepomoi wear the safety
<i>Ahaya! Kirir</i> Chepomoi	Ahaya! Crying lady Chepomoi
<i>Amadawa haya</i> ×2	assure me that I can go ×2

The warrior praised the lady Chepomoi as a way to motivate her wear the *lokoty*, the belt that had the magical power to protect them while going for violent raids. Other significant findings revealed that before the warriors could go for a raid sometimes some rituals were done. Women could be heard singing:

<i>Chesirani ee! Chesirani</i>	the animal ee! The animal
<i>Ahaa omaneke tikil</i>	aaha eat it all
<i>Chesirani ahaa! Omaneke</i>	the animal ahaa! eat it all

<i>Tukut ahaa!</i> ×2	all now can eat ×2
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The above song was sung during a ceremony to bless warriors in preparation to go for a raid. They are motivated and encouraged to be confident. After the warriors had tested meat, the community members were then allowed to eat and celebrate.

A question was posed in a questionnaire wanting to establish the role of songs to perpetuate the culture of violence. A large majority of respondents revealed that some songs have incited the community against the rival communities. Such songs ridiculed warring communities by portraying them as cowards, uncircumcised, with bad habits as well as encouraged their youth to raid and eliminate such communities. Thus, this has expanded narrowly the gap of trust and cohesion among the belligerents. For instance, a nomadic Pokot song that considered Turkana people as enemies was sang by a woman in presence of her sons as follows:

<i>Nyi weru</i>	You my son
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*Weghenoye koronu*  
land

Can you go away from our

*Taghe okumpo Turkana*

Go to Turkana land

*Pelee motowoikwa kunyoryo*

Burn their heads to pieces

This song has provoked young warriors to pursue and obliterate their perceived enemies. The song reminded warriors that it was their responsibilities to protect and defend their communities by all means and with all their abilities. And it was their responsibility to defend their land and animals the invaluable resources that has promoted their prosperity for centuries.

In Pokot, the song was a library of the past, present and future, thus they kept memories of trauma, hatred and protracted violence from one generation to another. This has largely sustained the traces of animosity among the belligerents for decades. One of the sages I interviewed reflected that a song is a pen to write history, mark an event as well as promote culture. It could point historical injustices, for instance, one of the songs has on and on reminded Pokot people that a segment of Trans-Nzoia County was their ancestral land or the Sook (Pokot) grazing field. The community was displaced from the region by the white settlers in 1919. The community has marked these social injustices using a song:

*Kampombao korenja*

Kampombao is our land

*Kaphepkoilei korenja*

Kaphepkoilei is our land

*Iya oleye laleyo*

Rejoicing in new found home

This song was composed when Pokot were hounded from Tran-Nzoia by white settlers. It was sung by an elder conveying the message that they were chased from Kampombao and yet it was their land. The contested land was said to be at Soi in Trans-Nzoia as pointed by one elderly woman, “Pokot doesn’t know to grab...our land has been taken at Soi in Trans-Nzoia...we hope to get it someday.” In the song the elder was wondering where to go, even though they finally settled in Makutano. He encouraged Pokot as a nation to reclaim their great-grandfather land. This song was unlikely to promote peace and harmonious coexistence among people, considering it provoked Pokot people to repossess their land. One could say that this was likely to be a time ticking bomb that could explode at any slightest provocation. However, one of the elders in FGDs pointed

that Pokot were peace loving people, thus they have never retaliated. The elders lamented that after the white settlers left the country, Africans of colonialist relics conspicuously grabbed their land. He hinted that the community was extremely hopeful that sometime to come they would repossess their ancestral land. This could be the surest strategy to attain peace and reconciliation in Pokot, considering the arable land could produce vast food reserves for the community and Kenyans at large. A similar song has been composed to contest grabbing of Pokot land in Kapedo. Here the song goes: *Korenja kapedo koro Pokot, iripchikey tomoelukuchepokonon*, translated as Kapedo is our land, we urge non Pokot people to quit otherwise they would remain as slaves or refugees in our land. The Pokot people have believed that Kapedo is their land inherited from their great-ancestors. It is evident from the word Kapedo, a Pokot word meaning a hole in a rocky. It needs, however, to be pointed out that according to Kenya's supreme laws; one was allowed to own a piece of land anywhere, within and without. This was primarily aimed to foster peace and social cohesion among people who are believed to be one in a one nation.

Some songs were found to be satirical, laughing about issues or happenings in the society. They encouraged warriors to be always alert as they defended community interests. For example, the famous Rolika, the guy who was killed and was put in a song explaining how he was killed. The song asked who told him to leave where he were? That was how he got killed. Moreover, one of the DPC chairs I interviewed observed that such songs challenged warriors: How many bulls you own? Where did you raid? How were you faring on in the community in terms of raiding? What titles do you earn? These songs had largely undermined peace in the sense that they have energized and motivated warriors to regroup and instigate dangerous raids.

The results established that some of the songs have indirectly activated violence. A large majority of respondents in the questionnaire revealed that such songs advised members of the community to be patriotic and not to betray the community at best, thus rendering it vulnerable. A warrior was heard singing: *Kikimuny Apollo kunekegh pikipiki ochech chen yokoria*, translated as beaten Apollo to jump over the motorbike oh! You are a coward man and worth no salt at all. This song was sung to warn Apollo, the chief not to reveal the identity of people thought to have committed heinous crimes in the society to the government security agencies. However, the chief went ahead and uncovered the

names of criminals against the norms set by the community, thus betraying the community. Subsequently, the members of the community waylaid the chief and he was thoroughly beaten and compelled to explain why he had betrayed community expanding its vulnerability as well as threatening its resilience against the harsh reality and enemies.

### Songs and Growth

The study found that in away peace has interlinked with growth of people. It was found that songs have been used as a strategy to promote peace and development as well as to appreciate the profound goodness of humanity. They have promoted the security of a region, protection of the community as well as life of people and economy. The elders whom I interviewed for this work emphasized that songs promoted peace and prosperity of people. For example, *chepalelayo* and *chepalale* songs, women and men sang as they danced along in traditional gears. The song encouraged unity and social cohesion of people. It promoted social transformation and healthy society; at peace with itself and all that is. Some other songs have encouraged national building, for instance, praised leaders who were development conscious, encouraged parents to take their children to school, praised people who had excelled in different sectors of economy, praised people with desirable behaviours, deemphasized laziness and so forth. Songs has also habituated certain actions aimed to promote equitable and caring society.

A large majority of respondents in the questionnaire revealed that songs condemned laziness in the community, for example, a woman condemning laziness could be heard singing: “You are the lazy, you are lazy, you need to be thrown out of this community.” Moreover harvesting songs have criticized those communities who had harvested sparingly. They disparaged laziness to greediness as well as motivated people who were faring on well in the spheres of life. This kind of songs have increasingly promoted growth and shared prosperity among people. They have motivated people to strive in achieving their potentiality fully as they were destined by God.

It emerged that songs have promoted peace, unity and harmonious coexistence among the Pokot people and among other pastoralist communities. For example, war songs emphasized on unity and courage among people which has translated to unity of purpose as seen in today’s lives of pokot people when undertaking activities such as farming. Another example, Tegla Lorupe Peace Foundation (TLPF) had used songs to unite

Pokot, Turkana people of Kenya, and Karimojong people of Uganda. As one of the women hinted, composing and performing transformative songs that injected the message of peace, love and harmony, as a way of inculcating and nurturing peace among the youngsters, it is likely to be a surest strategy to promote sustainable and lasting peace among the belligerents and growth. For example, the song that was earlier stated encouraging young men to go and burn Turkana people to ashes, could be recomposed replacing the lyrics of peace, love, and underlining the oneness of humanity. Moreover, church related songs were central in promoting peace. They spread the gospel of peace and reconciliation among the warring communities. For instance, in the song below, the singer asks God to grant the community peace, love, joy and happiness.

*Yesu ikonech kalya kau* ×2                      Jesus give us peace in our  
homes ×2

*Omba kau Ketumo nyoman* ×2                      in our home let us sing joyfully  
×2

*Omba kau ke tasa nyoman* ×2                      in our home let us praise Lord  
×2

*Omba kau ke liliyo nyoman* ×2                      in our home we praise Lord  
with joy ×2

*Yesu ikonech chomyot omba* ×2                      Jesus give us love in our homes  
×2

*Omba kau kesaah nyoman* ×2                      in our home we worship you ×2

*Omba kau keliliyeno nyoman* ×2                      we praise and glorify you ×2

*Omba kau kerapaka* ×2                      in our home we clap as we praise  
you ×2

This song is commonly sung in churches and events aiming to promote peace and development. As a Christian, whenever I am in church and the choir sings this song, it awakens the inner feelings of people. Young and old sings as they dance along spiced with beautiful gestures. This implies that the song penetrates to the inner core of a person, touching the soul, body and mind. It delivers the message of peace at home, as it is.

Example of songs that enhanced peace in Pokot were,

<i>Mitoni ngolyon nyole akonga,</i>	there is one word,
<i>Nyo mchinecha keyamtena,</i>	that we should preach,
<i>Akenamcha- Kalya,</i>	and maintain- peace,
<i>Akeghan lo owoy,</i>	and admit fully,
<i>Kuperurecha Tororot.</i>	God may bless us.

<i>Karam Kecham key ×3</i>	it's good to love each other ×3
<i>Kapchetulel</i>	people of Cheptulel
<i>Ka Kanyerus</i>	people of Kanyerus
<i>Ka Alale</i>	people of Alale
<i>Karimojong</i>	people of Karimojong
<i>Werpo Kalenjin</i>	people of Kalenjin
<i>Pich lapoy</i>	all people

The study found that there was a dichotomy between songs and work. Work was always accompanied with songs. Songs praised hardworking people, praised astute leaders, and encouraged leaders to be accountable as well as encouraged youngsters to emulate successful men and women in the society. This findings were augmented with that of elders FGD that songs encouraged people who were hardworking, praised astute and transformative leaders as well as were sang during various cultural activities and celebrations appreciating the outcomes of hardworking and success in life. One of the elders whom I interviewed noted that other songs have praised good performing people such as teachers, doctors, nurses, leaders, police, and elders appreciating their good work. Another elder reflected that songs have spurred development in the community by praising result oriented leaders. For instance, there were songs dedicated to leaders who had built schools, hospitals and constructed roads. Some of social institutions were named after such leaders to motivate them as they continue serving people diligently. From my own observations and experience of the researched area, Pokot people were extremely gifted to sing and dance. This talents and abilities can be tapped to create wealth for the community, in particular, and the country at large. For example, in *lalehyo* song women danced with men guided by a soloist. The song informed a wide array of things about the community, namely; condemned theft, praised pumper harvest, and

mentioned quire features in people like a man loved by many women. The findings from the questionnaire corroborated that songs were sources of income as they promoted cultural practices that attracted tourism. Moreover, school children have excelled in singing. They have received accolades for emerging winners in musical festivals. This has helped them to form singing groups such as kaywelank which has in turn generated incomes to the members. This resonates well with the findings that Pokot has extremely rich culture that could be tapped to generate income to the community. The indigenous songs, for example, could be recorded in albums and tapes in a bid to earn a living as well as build fame. The community could as well establish cultural centres displaying wide-ranging cultural art or social facts in a view to attract more foreign exchange. One of the women interviewed commented, “We sing so much but we have no means and exposure to record the songs to earn a living. Many of these songs have preached peace and encouraged hardworking.” A youth I interviewed added that, “A few educated people have recorded songs in CDs people that has generated incomes. For example, we have young girl artist who has generated a lot of resources out of it. This has promoted the well-being of people.”

Some of the songs performed during *sapana* were development conscious. The songs motivated women, men and children to work extremely hard as a way to generate vast wealth to grow prosperity of people. An elder could be heard singing: *Eliki nyemuru nyekales yaa, aliki nyemuru lokerei yaa* ×2 (this animal known as ostrich is strong like a rock ×2). This song was sung by elders at the start of *sapana* rite of passage according to singing protocol. They could wear jingles on their legs and ostrich feathers on their heads.

The above song informed that Pokot great-grandfathers used ostrich to generate wealth. It was noted that while elders were in the grazing fields, they could find the eggs of an ostrich which they took home and hatched them in the ash near the fire until they produced young chicks. The chicks were cared for, grew to become the adult ostriches. The feathers of this bird were used in two ways. One, exchanged feathers with goats or sheep. Two, used the feathers for the ceremonies like *sapana* to bring beauty and to make it more colourful. This promoted social and economic growth of the community.

The results further revealed that songs have emphasized the importance of peace and

development in the community. They have encouraged people to cooperate while dealing with new challenges of peace in a bid to cultivate harmony and human dignity. The post-conflict period people have composed songs hutching others to concentrate in development initiatives. The songs motivated people to farm or to work using their own hands. The findings resonated with that of the questionnaire that songs have encouraged schooling besides educating people on contemporary emerging issues. In schooling, songs encouraged girls and boys to join school considering it has unprecedented benefits. They deemphasized those cultural practices that have undermined schooling of children such as CR, female genital mutilation (FGM) and earlier marriages. In contemporary issues, songs created public awareness on emerging issues such as HIV/Aids, FGM, adult education, information technology, environment, drugs and substance abuse, and so forth. These findings mirrored that of interviewees that songs motivated parents to take their boys and girls to school in one spectrum, and on the other, the school children encouraged parents to take their peers to school as seen in this example:

*Opono monunge kusoman toketeka korenyo kumermer*

*Ompo kama kayelow kusoman toketeka korenyo kumermer*

Translation,

Bring children to learn so that we build our community

Those of mama *kaedou* (hill) to build our community

In this song, *mama Kaedou* were those young women who had not gone to school. The song encouraged them to join school in order to get empowered such that they could lend hand in community development. The song amplified the premise by gender revolutionists that if we educate a woman, we educate the whole nation. And if we empower a woman, we empower the whole nation.

### **Conclusion and Recommendations**

Cultural practices among the pastoralist communities like Pokots have increasingly fed the vicious cycle of violent conflict that has been experienced in the researched areas. Such practices such as *sapana*, songs, and cattle rustling, if carefully tapped, they are liable to create conditions necessary to foster lasting peace in one eye, and on the other, could be the critical enabler of human growth. That is to say, the culture of violence could be transformed to the culture of peace and prosperity through the concerted efforts of all

peace actors who shall abolish the structures of violence as they develop the resilient structures favouring sustainable peace. This study suggests that:

- ✚ The county government and the community should establish a number of cultural centres considering the area is very rich in terms of culture and attractive sceneries offering a huge potential for tourism industries to be established which is likely to transform the vicious cycle of violent conflict to lasting peace and shared prosperity; and,
- ✚ County government to develop peace perks with statures of prominent people who have contributed to global peace. This will always remind the community never again to engage in violent conflicts that has robbed the community prosperous lives for decades.

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# **An Evaluation of the Inauguration Speech Made by His Excellency the President of Kenya on 28<sup>th</sup> November, 2017.**

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## **ABSTRACT**

An inauguration speech in any political set up seeks to give an assertion of the round map on how to address issues that directly impact on the electorate. It should also be a timely moment to thank those who voted you into office. For the speech to be described as an all encompassing one it should appeal to all people regardless of their tribe, skin colour, religion or political affiliation. This paper looks at the inauguration speech which was made by His Excellency the President Honourable Uhuru Kenyatta who is the President of the Republic of Kenya on 28th November 2017 during his swearing in Ceremony. The speech could have been seen to have been made in on an effort to elevate and justify Uhuru's re-election both locally and internationally. Uhuru's first victory was challenged by the National Super Alliance in the Supreme Court. The Supreme Court annulled the election citing irregularities and illegalities in the election process. The primary objective of this paper is to find out how the speech pacified the electorate who felt that his re-election was supposed to be rubbished since a majority of voters did not cast their ballots. The paper would also wish to establish how the speech appealed to the locals especially those who did not support H. E. Uhuru during the campaigns and even in the casting of the ballot. Further, the paper would also wish to establish how the speech appealed to the people living beyond borders who had harboured negative feelings about Uhuru's re-election. Lastly, the paper strived to find out the rhetoric in H.E Uhuru Kenyatta's speech that appeals to the audience. This paper draws upon mostly primarily source the inauguration speech which will be downloaded online from the Government of Kenya website. The data will be analyzed qualitatively since the researcher will only describe the parts of the speech that have elements of pacifications both locally and internationally and those that appealed to t. The paper adopts a rhetorical analysis to discourse analysis. The results showed that the president pacified the electorate who did vote for him through the elements of education, healthcare, economy, democracy and international community. Further the results revealed that the president appealed to the ethos, pathos and logos of the electorate. Again, he uses the first person plural pronoun 'we', scriptural reference and repetition of words and phrases to appeal to the voters who never supported his re-election bid.

**Keywords:** pacify, inauguration speech, re-election, annulled, the Supreme Court

## **1. Introduction**

Language is used to come up with policies, shape and hand down values that define political alliance to put in place legal systems, formulate policies associated with the government language. Therefore, language plays a central and key role in politics. The language used in the political arena is described as political discourse.

According to Maalej (2012), political discourse is designed to foster agreement or approval about a certain world view or ideology in an effort to discourage negative feelings of dissent and disapproval. This can be achieved by persuading those who are against the mainstream ideology to adopt a different mindset.

National addresses are types of political discourse. Dijk (1997) describes discourse as political when it has a direct functional role as a form of political action in the political process. They are the most crucial activities under the umbrella of presidential public relations. (Schaefer, 1999). One such crucial address is the inaugural speech. An inaugural speech can be defined as a speech happening as part of an official ceremony or celebration when someone such as a newly elected official begins an important mission. Campbell et. al (1992) defines inaugural speech as the address by the president elect during the inauguration ceremony. The inaugural speeches are important tools in political communication for they are given at the beginning of the term and they give a platform for sharing not only nationals' thoughts but also vision. Like other ceremonial speeches, inaugural speeches have two functions; first, to explain how the world is socially built to the audience since it is a commencement address, secondly, to share and shape the community's ideals. (Wolvin, et. al 1999). Additionally, Campbell et. al (1990) came up with five important functions of the inaugurals. Firstly, inaugurals unite the listeners by constituting once more the people who can witness and okay the ceremony, further, inaugurals present opportunities for rehearsals of communal values which are drawn from the past time. Thirdly, they set beforehand the political principles that will govern the new administration. Additionally, the scholars advance that most importantly the inaugurals unify the audience.

## **2. AIM**

The aim of this study is to achieve the following objectives:

1. To find out how the speech of H.E Uhuru Kenyatta pacified the electorate who felt

that he had not been constitutionally re-elected.

2. To establish the linguistic strategies that H.E Uhuru Kenyatta used in the inaugural speech to appeal to the locals who did not support his re-election bid.
3. To establish the elements in H.E Uhuru Kenyatta's inaugural speech which appealed to the people living beyond borders who harboured negative feelings about his re-election.
4. To find out the rhetoric in H.E Uhuru Kenyatta's speech that appeals to the audience.

### 3. Background

Uhuru Kenyatta is the fourth and current President of Kenya. He was born into a political and wealthy family on October 26, 1961, to Jomo Kenyatta, Kenya's first President, and Mama Ngina. Uhuru received his early education from the St. Mary's school, Nairobi. After his high school studies, he was enrolled at the Amherst College in the United States where he pursued Political Science and Economics. He got married to Margaret Wanjiru Gakuo in 1991 and were blessed with three children; Jaba Kenyatta, Jomo Kenyatta, and Ngina Kenyatta. In 1997, he was elected as the branch chairman of KANU. He contested for a parliamentary seat but lost the election in December 1997. In 1999, Uhuru was appointed the Chairman of the Kenya Tourist Board, by Moi. In 2001, he was nominated by President Moi for a parliament seat, later appointed as Minister for Local Government. In 2002, he was KANU Presidential bearer but some of the KANU members left the party to support opposition leader, Mwai Kibaki who won the election. Between 2003 and December 2007, Uhuru was the opposition leader in the parliament. In 2005, Uhuru was elected the Chairman of KANU and in 2007, he backed Mwai Kibaki for re-election. Initially, Kenyatta was Minister for Local Government in January 2008 but later when a coalition government was formed, Uhuru was appointed as the Deputy Prime Minister. In 2009, he became the Minister for Finance until January 2012. He left KANU and launched a new party, The National Alliance in April 2012, later forming an alliance known as the Jubilee Coalition. In 2013, he vied and won the Presidency and supervised

the implementation of a new government administrative unit of countries which replace the previous unit of Districts.

In the last 8th August 2017, Uhuru Kenyatta vied presidency on Jubilee Coalition ticket defeating Raila Amollo Odinga the candidate of National Super Alliance. However, this election was nullified on the basis of illegalities and irregularities cited during the hearing of the case in the Supreme Court on 1st September 2017. The Supreme Court had ordered the IEBC to hold another presidential election within sixty days of the ruling. The ruling of the Supreme Court was historical since in Africa and over the world, no presidential election had ever been nullified. Another presidential election was held on October 26th, 2017. This, however, was marred with a low voter turnout of 38%. The low voter turnout notwithstanding Uhuru was announced the winner after amassing a total number of 98% of the vote. This win did not go unchallenged. A total of four petitions were filed against Uhuru's. Unanimously, the court determined that the petitions were unmerited thus dismissed. The country then organized an inauguration ceremony which took place on November 28, 2017, at Kasarani stadium, Nairobi. This is when the speech under study was delivered by the President elect.

#### **4. Previous Research**

This is not the first study to evaluate an inaugural speech. Several types of research have analyzed political speeches such as Al-saaidi (2015), Wang (2010), Miller (2014), Onaoniyi (2012), Amanda (2011), West (2014), McClay (2017), and KEPSA (2017), Liu (2012)

Miller (2014) did a comparative Analysis of the first Inaugural of presidents Franklin D. Roosevelt and Barack Obama. The following were the findings: 1) Both FDR and Obama's first Inaugurals provided American with a sense of hope and brighter future during a time when many doubted the faith of their own country. 2) Both speeches provide an insight into the history and state of the country at the time they were given. 3) Obama and Franklin were aware of the timing. 4) FDR and Obama both gave stirring inaugural addresses that provide a sense.

Amanda (2011) conducted a close Textual analysis of John Fitzgerald Kennedy's Inaugural. The finding was as follows; first, the speech had style and elegance,

characterized with short sentences and eradicated use of the word “I” in order to create a sense of fellowship and unity between the speaker and the audience. Secondly, the speech was begun with a strong ethos appeal. Also, there are aspects of the president being ready for progress and strong alliances. The speech notes that plans are in to ensure that the USA remains as the powerhouse of the hemisphere and that as a state they would exercise their power in order to secure their freedom and liberty. The other finding is that rhetoric terms were used in the inaugural speech many times.

Al-saaiddi (2015) examined the moves and strategies genre of the public speeches of former leaders of Al-Qaeda's bin Laden and Liberation Tiger Tamil Eelam's Prabhakaran convey their communicative purposes. The researcher noted that both speeches under analysis involved three important moves that are opening, argumentative and closure. Further, there are strategies and steps that are to be followed in the generic analysis of each move. In the opening move, Prabhakaran's speech used the traditional way of greeting in any political speech which differs from bin Laden's who used a religious salutation. The scholar noted that both speeches had closure move. Bin Laden emphasized on the crisis of the presence of the United States in Arab countries while the war between the Sin hall government and LTTE produced a crucial part in Prabhakaran's argumentation to legitimize the use of violence. However, the researcher noted that the two speakers used different ways of communication. An outstanding revelation of the study is that the choice of strategy is principally determined by what the speaker wishes to communicate. On the other hand, the occasion, the place, the audience and the subject of the speech are factors that influence the strategy chosen.

Wang (2010) undertook A Critical Discourse Analysis Of Barack Obama's Speeches. The researcher used Halliday's Systemic Functional Grammar. The analysis showed that Barack Obama's speech is characterized by more simple words and short sentences instead of the difficult ones. Specifically, his language is easy and colloquial. This he did with a reason to decrease the distance between him and the audience. Secondly, Obama applied transitivity in his speech to capture the governments past achievements, the present undertakings and the plans that he has for the future. With his transitivity, Obama arouses the American people's confidence toward the president and his government in the next four years. Thirdly, through modality analysis, Obama made his audience more

easily to understand and accept his political speeches by using modal verbs, tense and first-person pronouns. Obama made use of the simple present tense to present the domestic and worldwide situations spreading from political, economic and culturally concerned fields. By using simple future tense, Obama was able to lay out his following reforms and steps taken during his term. By doing so, Obama shows the government's objectives and builds the confidence of the audience.

West (2014) conducted A rhetorical analysis of President Barack Obama's Inaugural Addresses. The study revealed that President Barack Obama has a rhetorical style that differs from that the president who comes before him. Obama uses a holy rhetoric. He achieves this by referring to America as God's chosen people and stressing that America's divine destiny and responsibilities that are associated with this. Further, he holds a belief that those principles laid out by the founding fathers of America are more binding. The speech also gives an example of a broader definition of American national identity for it focuses more on shared ideas rather than a shared religion. Moreover, the findings show that President Obama's rhetoric is different in that he brings out.

Dastpak, et. al (2015) studied Obama's Political speech. The aim of the research was to establish the persuasive strategies and the incognito belief system of President Obamas's Public speech. The researcher used Fairclough's Framework Critical Discourse Analysis Approach. The results showed that Obama's speech could be condensed into pragmatism, liberalism, inclusiveness, acceptance of religious and ethnic diversity and unity. Further, the use of specific scriptural reference is an endeavour by Obama to spread the idea and belief system of affection that is the scripture references by Obama reinforces the thought of solidarity and charitable affection among the different individuals from the American various societies. Moreover, the basic subject of the discourse is the need to be enlivened and engaged by the American heroic past.

Onaoniyi, et. al (2012) conducted a pragmatic Analysis of Victory and Inaugural speeches of President Umaru MusaYar' Adua. The study was basically on the pragmatic functions of locution, illocutionary and perlocutionary acts of the speeches. The researcher found out that: 1) Umaru Musa Yar' Adua relied more on sentences that performed assertive acts than the other speech acts.2) the speaker used the sentences that were vindictive and

a directive to affirm his authority and exercise his power as the president. 3) The sentences that were expressive had the least Overall Relative Frequency Percentages, thus the president did not at a large extent exploit the sentences which expressed that his intentions were sincere.

McClay (2017) conducted a descriptive analysis of Donald Trump's Campaign Speeches. The following were the findings; firstly, Trump used the strategy of US vs. them as a means of distancing and delegitimizing the Establishment and foreigners, also, Trump uses appraisements, back grounding and suppression and misallocation of roles to legitimize his ideology and right to the presidency. Further, through the speech, Donald Trump asserts that America is weak because of the benign ineptitude and outright malicious corruption and greed of the Establishment. Another finding is that through the speech, the appalling ideology of racism, paranoia and xenophobia that unfairly and dishonestly draws false connections with immigrants, foreigners and political opposition come out.

Liu (2012) undertook a Genre Analysis of American Presidential Inaugural Speech. The scholar's aim was to reveal the communicative purpose of the genre of American Presidential Inaugural Address (APIA). The findings were that most of the speeches had the following eight moves as the possible generic; salutation, announcing entering upon office, articulating sentiments on the occasion, making pledges, arousing patriotism in citizens, announcing political principles to guide the new administration, appealing to the audience and resorting to religious power.

Mahmoud et al. (2014) studied the first inaugural address of President El-sis, to investigate the persuasive strategies and linguistic strategies. The study adopted a rhetorical and linguistic perspective. Results of the study showed that the address made use of the artist proofs which are identical to those proposed by Aristotle that is, appeal to Pathos, logos, and Ethos.

KEPSA (2017) conducted an analysis of H.E President Uhuru Kenyatta's Inauguration speech. The analysis revealed the ten key themes that the President promised to enhance; unity and nationhood, strengthening education, continued engagement with the international community, improving governance in public institutions, re-engineering the

agricultural sector to improve food security and cushion the country against the vagaries of weather, value addition and job creation, supporting manufacturing sector, creation of jobs and opportunities for the youth, strive to achieve 100% Universal Healthcare coverage for all households and increase affordable housing.

## **5. Theoretical framework**

The current study used Aristotle's model of Ethos, Pathos, and Logos and Atkinson's (1984) Linguistic strategies. It is important to note that the two approaches are used to analyze political speech. Secondly, they view political address as a spoken discourse prepared and delivered by a speaker to an audience to achieve a specific purpose. Further, the two approaches provide a theoretical framework that meets the purpose of the current study since it consists of a linguistic analysis and a rhetoric one. The sub-section that follows gives the theoretical framework of the current study.

### **5.1 Rhetoric analysis**

In doing a rhetoric analysis, one has to identify the basic ingredients for persuasion. Over two millennia ago, a Greek philosopher Aristotle wrote a lot on the art of rhetoric which he sees as a crucial part of human activity. Aristotle defines rhetoric as an art of speaking which applies to all forms of human communication. Over time, rhetoric was associated with politics, government and persuading people. Assmundson notes that rhetoric, as described by Aristotle, seems to have great significance in the world of persuasion.

While in the process of defining rhetoric, Aristotle came up with three means of persuasion: ethos, pathos, and logos. This paper focused on establishing how the President appeals the audience through his speech.

Ethos is the appeal to ethics through giving reasons and traits why the author is a trustworthy source of information. Ethos' involves making the speaker seem credible by a way of displaying practical intelligence, a virtuous character, and goodwill (Assmundson, 2008). A speaker who appeals to the audience by means of ethos he/she does so by using a stance which is morally correct. Ethos in discourse can be identified by looking for words or expressions which bring out the speaker's integrity, intentions or character. Some of these expressions are: I am sure, I believe, I am convinced, let me give you an assurance.

Mahmoud (2015) notes that Ethos is employed in order to establish a relationship

between the deliverer of the speech and his/her audience. In this understanding, this means is founded on the character of the speaker his/her good will, virtue, practical wisdom, and credibility.

Pathos is the appeal to emotions by trying to convince the audience through the creation of an emotional response. Assmundson describes Pathos shortly as the process which leads to the creation of positive emotions and connotations in the minds of the audience. Emotions are powerful means of modifying our judgments. It is likely that a positive suggestion will be more readily received well by listeners or readers than a message which has a negative connotation. To identify 'pathos' in a discourse, an analyst/researcher should search for expressions, words, and ideas as well as any comments that create positive emotions. For example, expressions which praise, which encourage proper plans, action words such as accomplish, success, achieve and words such as family, 'we' and together stir a positive response and help in the maintenance of hopeful mood. Aristotle characterized this means by pleasure and by pain. Since emotions are cognitive by nature, they enable people to make evaluations that influence opinions and judgments.

Logos is the appeal to reason/rational and logical thinking by trying to convince the audience through reasoning. Logos involves persuasion by a means of reasoning. Logos is the principle of appealing the audience by, making use of logical arguments. Persuasion by logos is the easiest to detect within the discourse. A speaker who appeals by logos uses if-then expressions, concrete numbers, results, and data or specific plans and theories that give a definite flow of the speaker's ideas.

Aristotle notes that the logos appeal is an obligation in speech for each speech represents a set of ideas which are based on arguments. The ideas form a basis on which judgment based on everyday experience can be made.

## **5.2. Atkinson's linguistic strategies**

Politicians use different methods that underlie their effective performance. As a result, people can notice that some speakers inspire their audience while others do not. Atkinson's linguistic strategies as highlighted by Mahmoud (2015) include three elements listing; repetition, contrastive pairs, religious citation technique, the use of specific

grammatical structures and the skillful use of the first personal plural pronoun 'we'.

Miller notes that one of the strategies that Obama connects with his audience is the use of plural third person 'we'. The use of 'we' lessens the gap between the President and the audience by including him as a citizen of America. This strategy enables him to be at the same level facing the same everyday struggles as ordinary citizens, in the eyes of the listeners. According to Halaman (2008) the use of the first plural personal pronoun 'we' is a simple but powerful inclusion strategy. Korhonen (2017) noted that the use of 'we' by Trump in his inauguration builds a sense of unity. Dastpak et. al (2015) notes that the first person plural pronoun 'we' has a general strength and it is a way of showing that solidarity is required especially in the season of national danger.

Another linguistic strategy as brought out by Dastpak et. al (2015) is using the scriptural references in order to reinforce the thought of solidarity and charitable affection among the different individuals from the American various societies.

### **5.3 The notion of pacification**

Pacification is from the word pacify, which means to make someone who is angry or upset be calm or satisfied. Pacification is an attempt to create or maintain peace. It's a means carried out by a government to keep the peace or end a conflict. It can also be defined as the act of appeasing someone or causing someone to be favourably inclined.

Tho (1980) defines pacification as the military, political, economic and social process of re-establishing local government which is responsive to and involving the participation of the people. It encompasses the provision of sustained, credible security, the assertion or re-assertion of political control and involvement of the people in the government and the initiation of economic and social activity which is able to self-sustain and expand.

Pacification should be geared towards advancing the; democratic process, the economic development, healthcare and social betterment. The economic element of pacification could include transforming squatters into landowners, creating conducive environments for Agriculture, improving means of transport and communication.

In health and education element of pacification, efforts are concentrated on illiteracy elimination possibly by making primary and secondary school affordable, provision of free medical care and improving sanitation The pacification from this perspective could

also include the erection of more classrooms, dispensaries, maternity wards, recruitment and training of teachers, nurses and technicians. The democratic element would strive to do away with injustice and social vices and ensure all citizens are given equal opportunities for advancement and equal protection under the law.

## **6. Methodology**

This research is qualitative in nature and the speech will be analyzed by employing Aristotle's three-tier approach and Atkinson's (1984) linguistic strategies with the aim of identifying the ways in which H.E Uhuru Kenyatta pacified and appealed to the people living within Kenya who did not support his re-election bid and those living beyond borders. The speech was downloaded from the government of Kenya website.

## **7. The data**

The data selected for analysis is the inaugural speech of President Uhuru Kenyatta which was delivered on 28th November 2017 at the ceremony marking his inauguration as the fourth president of Kenya at Kasarani Stadium. The choice of this speech as a sample text for the study is because of two reasons. First, it captures the inaugural address of President Uhuru Kenyatta after his re-election following the nullification of the first Presidential Election held on August 8th, 2017. Secondly, it gives us a true reflection of the President's sentiments as he took the oath of office when the country was divided on the basis of political affiliation.

### **7.1. Data Analysis and findings**

The following are the findings of the evaluation of the inaugural speech by H. E. Uhuru Kenyatta

Analysis of how H.E Uhuru Kenyatta appeals to those living beyond borders: He appeals to them in the following ways; by calling them '*Kenya's friends in the international community*'. He promises to '*strengthen the economic ties and bilateral and multilateral relations*'. Notes that they '*will fight together to free the world of international terrorism*'. He calls Africans '*my fellow Africans*'. Directs that any African visiting Kenya *would get a visa at the port* entry, Promises receding of political balkanization and negative politics

of identity and expansion of brotherhood to include more Africans. Addresses the East African community as ‘our Brothers and Sisters’...our closest friends.’ Uses the phrases ‘brothers and sisters’ twice and compares them with Kenyans by using the phrase ‘your Kenyan brothers and sisters’ twice. H.E Uhuru Kenyatta extends an invitation and goodwill to the East African community by assuring them that they would need an identity card to “...to work, do business, own property, farm...find a willing partner, marry and settle in Kenya. Further, he reminds the East African Community that they will be subjected to the same rule of law just like Kenyans. “...You shall be subject to the same rules and laws as your brothers and sisters.’ From this part of the inauguration speech, H.E rules out any form of discrimination regardless of religion or skin colour. He does not differentiate between those who supported him and the ones who did not. By doing so he appeals to those living beyond borders who did not support his re-election bid.

Another linguistic strategy that H.E Uhuru Kenyatta uses to appeal to all including those who never supported his bid for re-election is the use of first plural person pronoun ‘we’. As noted by other researchers, the use of ‘we’ is a show of a unified front and that the President identifies with the audience as part of them, facing the same challenges. In the speech, the first person plural pronoun ‘we’ is used 88 times. Some of the phrases in which the first plural person ‘we’ is used is as listed: *We may have... We may say... We thank him...We overcame...We faced... We have resolved...We have sworn...We have lived...We disagree...We have deviated...We are a people...We should not destroy...*From these findings it can be advanced that H.E. did not exclude those who never voted for. He refers to them as part and parcel of the decision makers. Through this strategy the president appeals to all the electorate regardless of whether they voted for him or not.

Another strategy that the President uses to appeal to the people is a scriptural reference. Some of the examples from the inaugural speech are: ‘.....I remind every Kenyan that God commands us to love and protect our neighbour.’ This scripture is drawn from the book of Mark 12:31. He does this to involve mutual co-existence of Kenyans regardless of the community they come from. He urges Kenyans to be each others’ brother’s keeper(Luke 17:1-4). Again, H.E Uhuru referred to the scripture in the book of Psalms 106:1 he thanks the ‘Almighty God’ in the very beginning of his speech. The President also quotes the

scriptures in the book of Isaiah 43:2, that ‘When you pass through the waters, I shall be with you. When you pass through the rivers, they shall not overwhelm you, when you walk through fire, the flames will not consume you.’ H.E Uhuru also says that ‘Our God is faithful ‘scriptures from the book of 1 Corinthians 1:9 and Deuteronomy 7:9. This finding reveals that H. E. Uhuru acknowledges that there is a power beyond the political power that was bestowed on him upon his re-election as the president of Kenya. The scriptures apply to all regardless of their political affiliation. Based on this assertion, it follows that the president was able to appeal those who never supported his bid for the presidency.

The President addresses all the sectors in the country: education, agriculture, healthcare, democracy, economy and international relations. Pacification, as noted above, can be done through the elements of the economy, health, education, and democracy.

Some of the phrases and clauses in H.E Uhuru Kenyatta’s speech which meet democracy element of pacification are; *engage judiciary to address the protracted delays in our justice system, Keep to rule of law, The law must reign supreme, The law must be the refuge for every Kenyan, None of us should break outside the law or constitutional order, Refers to the constitution which acknowledges the supremacy of the Almighty God of all creation, All our expectations are delivered, some in our favour and some against but that is democracy and the rule of law, Our constitution is no piece of paper, but rather the living expression of our desire to live under the rule of law.* H.E notes that for us to ‘*build a united, stable and prosperous Kenya, every Kenyan should ‘keep to the rule of law.* H. E. Uhuru presents himself as a law abiding citizen an aspect

The following clauses and phrases from H.E Uhuru Kenyatta’s speech enhance the pacification element of economy; *Every county is a centre of economic development, We will grow and sustain this manufacturing sector and raise its share of the national cake from 9 to 15%, develop sub-sectors, agro processing, textiles and apparel, leather processing, construction materials, innovation and IT, mining, and extractives, value addition: value-and-job creation, key trading partners: enables Kenyans to get the most out of their products, innovate negotiations to open new international markets for our products and to attract even more new investment, re-engineer our agricultural sector in order to be food secure, invest in securing our water towers and river ecosystems to*

*harvest and sustainably exploit the potential of water resources, address idle arable land ownership and utilization, facilitate large scale commercial agriculture to help diversify our staples, create vibrant economies, means of economic prosperity, creation of 1,000 small and medium scale enterprises in agro-processing, build on ongoing efforts, such as the Vw and Peugeot motor-vehicle assembly plants. Fertilizer blending industries, creating job opportunities for our young population, we have built a firm foundation for economic takeoff, our business environments have made us the fastest, improving business environment anywhere in the world, we have risen 56 places in the World Bank's Ease of Doing Business Index, from 136th to 80th, building an entirely new world-class railway system...kilometres of access roads to connect producers to markets, connected thousands of schools and millions of homes to electricity.*

The other element of pacification that H.E Uhuru Kenyatta brings out in his speech is the health element. The health element is brought out by use of the following phrases and clauses;... *have begun to transform health care delivery, free maternity programme, see the delivery of our children as a life-threatening experience, expansion of public hospital infrastructure and the transformation of NHIF have improved access to quality health care for millions of Kenyans...6.8 million beneficiaries of NHIF medical cover, target 100% universal Healthcare coverage for all households*

President Uhuru Kenyatta pacifies the audience by assuring them of access to the education element. This is achieved by the use of the following phrases and clauses in his inauguration speech; *reformed our education system, restored the credibility of our exams, made education the great equalizer by removing exam fee, providing digital learning devices, reviving our technical and vocational training*

H.E used the strategy of inclusivity to appeal to those who did not vote for him. This aspect of inclusiveness is depicted in the following clauses... *the Kenyan voter has been the most important player in the election, Everyone who voted played a role in strengthening our democracy,-We may have chosen different candidates, and different visions, but each of us voted for a better life,-Listened to my competitors, and in the spirit of inclusivity, I will endeavour to incorporate some of their ideas, The election was not a*

*contest between a good dream and a bad dream; it was a contest between two competing vision. I believe that those who voted for me chose the better vision,-This, however, does not invalidate the aspirations of those who did not vote for me, To be the keeper of the aspirations of those who voted for me and those who did not, I will be the President of all,-I will devote my time and energy to build bridges to unite and bring prosperity to all Kenyans,-You won the confidence of Kenya's voters – some of the most discerning anywhere in the world, Serving Kenyans without regard to political affiliation or choice, Every Kenyan deserves our full attention, Kenyans have shown their resilience in calming the passions that accompany political competition. the path to a better future is unity and leaving no one behind, I have begun reaching out to all leaders across the political divide, restarting my willingness to work with them.*

Another way which H.E expresses inclusivity by use of phrases such as *as brothers and sisters,fellow Kenyans, my fellow Kenyans*, Kenyan voter refers to all as ‘You, Kenyans, Every Kenyan ladies and gentleman, fellow citizens’..

H.E Uhuru Kenyatta appeals ethos at the audience especially those who never supported his bid. This comes out through the use of the following clauses as propagated by (Ammundson 8).. *I believe... is used six times, I know...You will agree with me...I know that we can build*. These clauses present the president as a confident leader who is convinced that every undertaking is achievable with determination.

As noted in the theoretical framework, H.E Uhuru used if-then expressions, concrete numbers, results, data or specific plans and theories that give a definite flow of the speaker's ideas to appeal to the audience logos. If-then expression is ‘;...I believe we must address ourselves to if we are going to build a united, stable and prosperous Kenya for all.’ Concrete numbers in the speech are;*123rd day since we began...56 places...500,000 Kenyans...5 months...700 campaign meetings...62 percent of all Governors; 61 percent of all Members of National Assembly, 58 percent of the Senators; 55 percent of the membership of the county assemblies,5 years...100% universal healthcare...Twenty minutes...Two hours...6.8 million beneficiaries...13 million Kenyans...500,000 new homeowners...1000 small and medium scale enterprises...50 years...He uses these concrete numbers to make the audience to have confidence in him thus appealing to them*. It is clear that the president is aware of the exact numbers of the

various nouns that he refers to. He appeals to the electorate by referring to definite number of what he talks about. This way he rules out any case of guesswork thus appealing to all as leader who is sober and is definitely aware of what he is talking about. If -then clauses sets conditions to all regardless of their political alignments.

H.E gives data and results in his speech. Some instances include: 'Today is the 123rd day since we began. Today's inauguration marks the end of our electoral process'...*Entrenching devolution which has led to the delivery of government to the people....Firm foundation for the economic take-off has resulted in becoming the fastest, improving business environment anywhere in the world. In three years, we have risen from 56 places in the World Bank's resulted in new businesses which can be shown. ...Connections of thousands of school children can study at night...Kathingiri primary school having a mean score of 404 in 2017 results are seventy-one exam candidates sent to national schools. Expansion of public hospital infrastructure and transformation of NHIF resulted to improved access to quality healthcare for millions of Kenyans. ...62% of all Governors, 6% of all MPs, 58% of all Senators and 55% of MCAs should lead to the fulfilment of the Jubilee Agenda.* He appeals to the voters who did not support him by making a pronouncement that there is a result for what we engage ourselves in. To an extent he puts it clear that what the electorate did there was a result. He also presents himself as a strategist and development conscious leader.

H.E Uhuru Kenyatta appeals to the pathos of the audience by using expressions of praise which encourage proper plans and those that depict the success, achievements and accomplishments that as a country we have managed to have. Some of these expressions and clauses include'... am proud that we have entrenched devolution'...'We have built a firm foundation for economic takeoff'...'We have risen by 56 places in the World Bank's Ease of Doing Business index from 136th to 80th...We have connected thousands of schools and millions of home to electricity. More than 500,000 Kenyans have travelled the Mombasa-Nairobi route cheaper, faster and safer than ever before.Have made investments and reforms that have begun to transform healthcare delivery in Kenya...Transformation of NHIF has improved access to quality healthcare for millions of Kenyans. We have restored the credibility of our exams...Most resonated with our agenda

*...You will recall Jackson - diagnosed with kidney failure...had to travel two hours to and from Nairobi for dialysis...today he takes twenty minutes to Murang'a for dialysis session. It is our intention to facilitate affordable housing...We will grow and sustain the manufacturing sector ...My administration will focus on developing agro-processing, textiles.....We shall reach out to our key trading partners to work with us to achieve a win-win outcome...We must completely re-engineer our agricultural sector. We shall invest heavily in securing our water towers and river ecosystems. We shall provide, together with other actors, key enablers within the farming process that will address distribution...We will engage with the judiciary to address the protracted delays in our justice system...Through parliament, we shall enact legislation to strengthen fiscal discipline. I am directing that any African wishing to visit Kenya will be eligible. From this analysis the president clearly and precisely outlines what as an incumbent president has achieved together with the concerned. This is a way of appealing those who did not support his presidential bid. He points at the specific areas that they have managed to develop. He also sets straight his development agenda.*

H.E Uhuru displays goodwill and virtuous character by using the following expressions:*...When the ICC demanded compliance of US...we complied...When the Supreme Court ruled to invalidate our election, despite our having won...we complied,...This administration has demonstrated its readiness to live and lead by the rule of law...I will play my role as constitutionally defined...We will deliver our promises to the people of Kenya...I am greatly humbled by this...We are determined to fulfil the Jubilee development...I will dedicate all my energies...Restarting my commitment and expressing my willingness to work with them...We will continue to fight together. All these expressions bring out H.E. Uhuru as a president who is a virtuous leader and is able to stir the country to greater heights in terms of wellbeing. Again he comes out as a leader who is determined and dedicated to deliver to the Kenyans all the promises he made during his campaign.*

## **Conclusion**

Based on the above discussion, the following conclusions can be made. According to Aristotle's, three-tier rhetorical Analysis, it is clear that H.E Uhuru Kenyatta's Inaugural speech appeals to the logos, pathos, and ethos of the audience.

The evaluation of H.E Uhuru Kenyatta's Inaugural address shows that the speaker knew that his re-election was not supported by all. He employed a number of linguistic strategies and rhetorically appeals to all the members of the audience, more so those who did not support his re-election bid. The speaker does this by using inclusivity term, the plural first person pronoun 'we' making reference to the scriptures and repetition. Moreover, the speaker seemed quite aware of the pacification tools which were at his disposal. He pacified the electorate by highlighting on the specific developments made in the education sector, the economy, the healthcare and commitment to democracy. Further, H.E Uhuru Kenyatta appeals to those living beyond borders by unleashing the plans put in place to strengthen their relationships and also to foster development with them. The speaker rhetorically appeals to the audience pathos, logos, and ethos. Aristotle's three-tier theory of rhetorical analysis was used to bring out all these aspects of the speech.

### **Suggestions for future research**

The current study evaluated H.E Uhuru's inaugural speech delivered on 28th November 2017 from rhetoric and linguistic perspective. Similar studies can investigate the inaugural speeches by the first, second and third Presidents of Kenya especially during the taking oath of office celebration especially during the second term of their re-election. Contrastive studies can be done on such addresses. Again, a researcher can investigate the moves in H.E Uhuru's inaugural speeches.

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## **A comparison of Descriptive English Compositions of Visually Impaired and Sighted Students in Kenyan Secondary Schools**

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### **ABSTRACT**

Language is common to visually impaired and sighted students because they both use language to communicate ideas, feelings, and emotions and above all to describe their worlds. Descriptive writing brings alive the object of description, be it real or imagined. To do this effectively, it heavily exploits sensory details, sight being key among them. Descriptive essay writing is one of the topics tested in the Kenya Certificate of Secondary Examination (henceforth KCSE) that is sat by both categories of students. However, there have been few attempts to comparatively study the descriptive characteristics of English compositions of visually impaired and those of sighted students. The information is crucial in determining whether the visually impaired learners are disadvantaged in any way. This is where this paper comes in. Purposive sampling was used to select Salvation Army (S.A) Thika High School for the Visually Challenged Persons and Broadway High School, both found within Thika Municipality in Thika District, Kiambu County in Kenya. The population of the study comprised the following categories of Form Three students; the totally visually impaired, the partially sighted from S.A Thika and sighted from Broadway. Form Three and Form Four teachers of English were also part of the sample. Data was collected from descriptive compositions written by the students and from questionnaires and interview schedules administered to the sampled teachers. Compositions written by visually impaired students were debrailled. Words and phrases were then extracted from the compositions according to the various senses. They were analysed in order to determine whether they were used in equal measure by both sighted and visually impaired students. Lexical density was then calculated, data presented in tables and results discussed. The findings in this paper revealed that visually impaired students used fewer descriptive terms in total and in all the senses than their sighted counterparts. The sighted students predominately exploited the sense of sight in their

description while the visually impaired students mainly used the sense of hearing. The paper further established that even if all the sensory details used by the visually impaired students were combined, they would not match with the ones obtained from the sense of sight among the sighted students. The paper therefore concluded that there is a true correlation between sightedness and descriptive writing. The following recommendations were made: that the teachers deliberately present as many first-hand descriptive concepts in class as possible to the visually impaired students; schools for the visually impaired consider admitting sighted students to learn together with the visually impaired for more linguistic input; KNEC consider adapting descriptive composition topics to avoid disadvantaging the visually impaired students.

**Key Words:** Descriptive writing, visually impaired students, sighted students, sensory details, congenitally blind

## **1.0 Introduction**

Descriptive writing, sometimes referred to as showing writing describes a particular person, place, object or event in great detail. It involves the use of elaborate sensory language, specific details, concrete words and figurative language in order to form pictures and images in the readers' minds. In a description, writers often use words to create a mental word picture of what they describe (Kinneavy & Warriner, 2002)). To achieve this, writers are expected to avoid vague and general words and instead use precise terms.

According to Reddy & Kusuma (2004), vision is crucial to normal language acquisition because it is responsible for a great deal of human communication. The absence of this sense can lead to significant changes in language patterns due to insufficient input and reinforcement from the visual feedback. This will consequently affect the nature of description since language acquisition depends on discovering and identifying objects and actions. This is difficult for children who cannot see such objects and actions. Visual

impairment may therefore affect one's ability to give a good description since description entails vision as the dominant sensory input.

Visual impairment is an umbrella term that includes all levels of visual loss from total blindness to correctable visual limitations. Concepts used interchangeably to describe children whose vision is impaired include: visually handicapped, visually disabled, persons living with visual impairment, visually impaired, blind, sightless, partially sighted and low vision (Smith, Palton & Polloway, 2011). The paper adopted the term "visually impaired" to refer to blind children because it is one of the most polite terms of all the rest and this was indeed the group that was the focus in this paper. This group is considered legally visually impaired with a visual acuity of 3/60 according to the Snellen measures chart, a device that determines the visual acuity fraction measures of individuals. According to the American Foundation for the Blind (2018), visual impairment (distance and near vision) was defined as a binocular presenting visual acuity of less than 6/18 (20/63).

Sighted children on the other hand have an opportunity to explore and interact with the world, link words with objects and tie concepts and categories to the environments which they represent. They will subsequently give a description based on the amount of visual information they have. According to Cruinkshank (2008), visually impaired students differ from sighted students in the way they describe their environment. Both have different approaches in their descriptions. The language of space, colour and movements may have different associations for the visually impaired children.

The study focused on the sense of sight because it is the most exploited in any description and the largest percentage of human information comes from the visual channel. Vision also coordinates the rest of the senses. The study limited itself to the totally visually impaired category to establish if indeed their state would influence the kind of description they made. The sighted students were sampled for comparative purposes.

## **2.0 Literature Review**

Below we present an overview of descriptive writing before looking at the role of vision in description. Finally, we will look at visual impairment and description.

## **2.1 Descriptive Writing**

Descriptive writing and sensory impressions cannot be separated because sensory details are the basic ingredients of all descriptions. Any good description should form pictures and images in the reader's mind regardless of the writers' purpose. The sensory data enables writers to create a scene for their audience through description by making the characters vivid. According to Kinneavy & Warriner 2003 the factual and realistic details create an exact image that cannot be misunderstood and can be tested or checked for accuracy by ones' readers.

Descriptive writing involves all the senses. This is because as noted by Reinking, Hart &Osten (2002) sensory impressions reflecting sights, sound, taste, smell and touch form the backbone of descriptive writing. He further says they often build toward one dominant impression that the writers want to evoke. Congenitally visually impaired children are restricted in this respect. The use of concrete and specific words is a writer's best assurance of writing not only vivid but also fully developed descriptions. This is not necessarily expressed explicitly in a direct statement but it is often revealed indirectly through the writer's choice of words and phrases according to Kirszner & Mandell (2001). In our study, sighted students may have had the advantage of using all the senses in their descriptions but congenitally visually impaired children were restricted in this respect.

Authors of a descriptive composition must carefully select details to support their dominant impression. The details should be consistent with the dominant impression. One of the ways of making the details specific is by using precise nouns, verbs, adjectives and adverbs according Kinneavy & Warriner 2003). All good descriptive writing whether objective or subjective, relies on specific details. The writer's aim is not simply to tell readers what something looks like but to show them. That is why descriptive writing is also called showing writing. Every person, place or thing has its special characteristics and writers should use their power of observation to detect them. Then the writers need to select the concrete words that will convey their dominant impression. The only focus should be quality and appropriateness to his purpose of writing. This study sought to investigate if the students both sighted and visually impaired, used specific details in their compositions.

## **2.2 The Role of Vision in Description**

Sight is one of the most important senses in a precise description because description exploits the sense of vision. According to Reddy & Kusuma (2004), the centrality of vision in normal language acquisition cannot be overlooked as it is largely responsible for a great deal of human communication. Consequently, the absence of this sense can lead to significant changes in language patterns due to insufficient input and reinforcement from visual feedback. Language acquisition depends on discovering and identifying objects and actions, something that poses a serious challenge. Since descriptive writing employs the sense of sight as the dominant input, children who cannot see objects and actions may be disadvantaged.

According to Gargiulo (2011), vision is considered as the primary sense. This is because of all the senses it provides the most information to the brain. Vision collects and integrates both near and distant information in terms of shape, colour, form, size, texture, movement, spatial location and relationships. According to Bishop (2004) and Gargiulo (2011) it is only vision which is capable of perceiving a large number of bits of information and giving the brain a wide variety of it instantly and all at once. The information will further be used to provide a good description. Bishop (2004) further notes that even the combined senses of hearing, touch, taste and smell do not provide the rich variety of information that vision does. This implies that if the sense of sight is impaired or lost, it is difficult to compensate for the reduction in information through the other senses since we use eyes in every activity we perform as pointed out by Gargiulo (2011).

The sense of vision gives children the ability to explore, organize and make connections between different experiences. These connections help them make the most out of those experiences.

According to Heward (1996) vision is thought to be a coordinating sense, and approximately 80% of information received by a sighted person comes from the visual channel. Visually impaired children must obtain a large amount of information by listening. It is a misconception that visually impaired individuals have a super sense of hearing or listen better than sighted peers. It is through proper instruction and experience

that they will be able to use their hearing more efficiently (Harley, 2008).

The absence of vision, according to Bishop (2004), forces other sensory channels to provide initial sensory input data to the brain. This however, will never have the same motivational power as sight does. It has also been noted that children with normal vision without other disabilities learn constantly from their experiences and interaction with the environment. The sense of sight provides a variety of detailed information about the environment and relationships between things in that environment as they move about. This enables sighted children to produce enormous useful knowledge from everyday experiences. This would probably influence the kind of description they would produce. According to Bishop (2004) visual impairment however affects most of such incidental learning.

### **2.3 Visual impairment and Description**

Visual problems create difficulties in exploring and interacting with the world, linking words with objects and tying concepts and categories to the environments which they represent (Dean, 1996). According to Cruinkshank (2008), visually impaired students differ from sighted students in the way they describe their environment. Both have different approaches in their descriptions. The language of space, colour and movements may have different associations for the visually impaired children.

Heward (1996) Cruinkshank (2008), Harley (2008), Heward (1996) and Reddy & Kusuma (2004) observe that some things are inaccessible to touch such as distant views, colour and movement and making them difficult to describe. Harley (2008) also agrees that some items such as the sun, moon and stars are inaccessible. Some items are too large to be observed with understanding by touch; others are too small to touch. Some are too fragile, some move fast and others are difficult to touch because they are contained behind glasses such as liquids in thermometers. They further argue that it is not possible to teach space and time to congenitally visually handicapped children. Gulliford (1992) notes that, important ideas such as shape, number and size have to depend on tactile experiences. So the visually impaired individual's world is limited compared to that of a sighted one.

Heward (1996) says that many concepts that children with normal vision seem to acquire

effortlessly may not be learned at all by visually impaired children. Alternatively, they may be learned incorrectly unless someone deliberately teaches them. It is necessary to plan and present a great many first-hand experiences to enable children with visual impairment to learn to do things independently. However, even when a concept is deliberately presented to visually impaired children, they may not learn it exactly the same way that children with normal vision would. This is because the other senses may not totally make up for loss of vision. The sensory input data to the brain by other sensory channels does not have the same motivational power as vision does as Bishop (2004) asserts.

Children who are visually impaired perform more poorly than sighted children on cognitive skills requiring comprehension or relating different items of information. Lack of vision makes it difficult for the visually impaired children to literally and cognitively see the connections between experiences in their environment. This will further affect the kind of description the visually impaired will make (Reddy & Kusuma, 2004).

### **3.0 Statement of Issue**

The essence of descriptive writing is to vividly bring alive the object of description, whether real or imaginary. This kind of writing heavily relies on sensory details, the predominant one being sight. The fact descriptive writing is tested at the Kenya Certificate of Secondary Examination underscores its importance. Both sighted and visually impaired students tackle the same descriptive essay. As we have already seen, literature shows that vision is a coordinating sense, and close to 80% of information received by a sighted person comes from the visual channel. This suggests that students with visual impairment are at a distinct disadvantage. However, locally, there have been few attempts to comparatively study the descriptive characteristics of English compositions of visually impaired and those of sighted students. The information is crucial in determining the extent to which visually impaired learners may be disadvantaged in the writing of the descriptive compositions, given that it carries twenty marks which is a third of the total for paper 3. Plugging this gap in knowledge was the motivation for this research from which this paper arose.

#### **4.0 Research Methodology**

This paper employed a descriptive research design because the focus was on the data from the students' English compositions. Purposive sampling was used to select Salvation Army (S.A) Thika High School for the Visually Challenged Persons and Broadway High School, both found within Thika Town sub-county, Kiambu County in Kenya. S.A Thika High School was purposively sampled because, at the time of the study, it was the only fully established secondary school in Kenya that admitted students with visual impairments from form one to four. The other School, St. Lucy, only had Form One's and it was not yet fully established. Broadway High School was also purposively sampled because it was within the same sub-county as S.A Thika and it was also nearly at par with S.A Thika in terms of academic performance. The population of the study comprised the following categories of Form Three students; the totally visually impaired from S.A Thika and sighted from Broadway. Form Two teachers of English from both schools were also part of the sample: Three teachers from S.A Thika because there were three streams in Form Two and Two from Broadway. The teachers were purposively sampled because descriptive writing is taught in form two and they were the ones who handled the classes. Data was collected from descriptive compositions written by the students and from questionnaires and interview schedules administered to the sampled teachers.

Simple random sampling was used to select compositions from Broadway. Purposive sampling was used with S.A Thika to select compositions for the study. The students were divided into three streams and taught by three different teachers of English. All of them were subjected to composition writing in order to create a natural situation. Then compositions from all the thirty eight congenitally visually impaired students were purposively sampled according to the school enrolment. Compositions of the remaining six students were not sampled because it was assumed that their data would affect the results of the study because the children acquired blindness after they had acquired language. Broadway had two streams in Form Three taught by different teachers of English. A descriptive composition (the same one as for S.A Thika) was administered to both streams so as to create a natural situation. Then thirty eight compositions were randomly sampled from a total of eighty four with each stream providing half of the

number, for uniformity purposes. S.A Thika was the determining because it had thirty eight congenitally visually impaired students in all the streams, fewer than Broadway school. In total seventy six compositions were read and analysed. Compositions written by visually impaired students were debrailled. Descriptive words and phrases were then extracted from the compositions. They were analysed according to the various senses in order to determine whether they were used in equal measure by both sighted and visually impaired students. Then lexical density was calculated, data presented in tables and results discussed.

## 5.0 Results and Discussions

### 5.1 Descriptive Lexical Items and phrases in the Students' Compositions

Thirty eight compositions on the topic “Describe a wedding ceremony you have attended” were read and analyzed for each category of students and the following was observed:

**Table 1: Frequency Descriptive units in the compositions of the Visually Impaired Students**

Sensory input	Frequency	Percentage { % }
Hearing	45	45.45
Touch	17	17.17
Smell	13	13.13
Taste	12	12.12
Sight	12	12.12
Total	99	100.00

As seen from the table, the total number of descriptive lexical items and phrases was 99. Descriptive words and phrases from the hearing sensory input dominated the essays with

45.45%. Those appealing to the sense of touch followed with 17.17%. The sensory input from the sense of smell was third with 13.13%. The senses of taste and sight gave the least number with 12.12% each. These scores imply that the visually impaired students use the sense of hearing as their primary input to get information from the environment. Subsequently, they use the same information in their descriptions.

**Table 2: Frequency Descriptive lexical items and phrases in the compositions of the sighted students**

Sensory input	Frequency	Percentage { % }
Sight	164	55.97
Hearing	61	20.82
Touch	28	9.56
Smell	21	7.17
Taste	19	6.48
Total	293	100.00

The above table indicates the distribution of descriptive terms in relation to the various senses. These scores indicate that the sense of sight at 55.97% outstrips the other four senses combined since they only amount to 44.03%.

**Table 3: Frequency Descriptive lexical items and phrases in the composition of both visually impaired and sighted students**

Category	Sensory input					Total
	Sight	Hearing	Touch	Smell	Taste	
<b>Visually impaired</b>	12	45	17	13	12	99
<b>Sighted</b>	164	61	28	21	19	293

The table above shows the distribution of descriptive lexical items and phrases for both visually impaired and sighted students. There were a total of 392 lexical items and phrases used in their descriptive compositions. The visually impaired category provided 99 of these, forming 25.26% while their sighted counterparts gave the bulk at 293 which is 74.74%. The

difference was a much higher proportion. It was apparent that the visually impaired students were disadvantaged in descriptive writing.

### **5.3 The Descriptive Characteristics of the Compositions of the Visually Impaired Students**

#### **(a) The sense of sight**

Some descriptive words connected with colour, size, shape, movement, location and directions, which fall under this sensory input, were encountered. Words such as **white, red, tall and short** were used in the following contexts:

- 1 “.....all the people were in **red** garments which really.....”
- 2 “.....other was dressed in..... *butiful* [*beautiful*] **tall** dress.....”
- 3 “The bride was **a short** lady.....”

The words and phrases were used to describe the people and objects as well as locate specific places at the wedding. However, some of the descriptive words in this sensory channel were wrongly used. For instance in the colour class, some students decided to dress everybody at the wedding in red garments. This is not realistic and practical in real life situations. People come dressed in different colours depending on an individual’s culture, taste and role at the wedding. Moreover, a section of the crowd could be dressed in uniform or observe a certain dress code. Other students did not specify who exactly was dressed in what colour or what colour of flowers and ribbons decorated what.

The students were able to use such words in their description because of their teachers’ input, feedback in class. When teachers were interviewed on how they prepare their students to handle descriptive topics, they said they: hold class discussions on descriptions of people, objects and events. They also read out some samples of descriptive compositions and explain some of the descriptive concepts encountered. Further, they present descriptive concepts such as colour, spatial location, movement, size and shape in class deliberately.

However, according to Bishop (2004), even if a concept is deliberately presented in class, the visually impaired students may learn it wrongly miss it completely, or understand it differently from the way sighted children do. This could explain why some students dressed everyone in one colour.

In order to give a good description, writers should use precise and specific details. However, in most of the descriptions, students used vague and general adjectives of opinion such as **beautiful, nice, smart, and wonderful**. According to Tichy (1988) such adjectives convey little meaning when used loosely. The visually impaired students made an effort to revivify such adjectives by adding the degree adverbs “very” and “quite” as in:

4 “... the bride was *very beautiful*.....”

5 “This was *a quite interesting day*.....”

6 “...clothes which were *very smart*...”

However, in the absence of concrete details such overworked intensifiers not only lost their impact but also weakened the compositions. A specific word has fewer meanings but says more than a general and vague term. According to Tichy (1988) specific details lend vividness and precision to any description. Surprisingly, 65.79% of the students used the degree adverb ‘very’, 2.63% used ‘quite’ and 31.58% did not use them. This contradicts Harley’s (2008) observation that the unsighted individuals do not use intensifiers.

According to Leech & Svartvik (2000), Crystal (2000), Kinneavy (2002) and Hall (1994), action verbs are more descriptive than other verbs. Verbs such as **marching, peeping, kissing, waving** and **smiling** denoting actions likely to take place at a wedding were not present in the students’ compositions. People have to see such actions, the gestures or non- verbal cues in order for them to label them correctly. Obviously, the visually impaired students were disadvantaged in this respect.

Another observation is that the students lacked variety in location and direction words. Words such as **behind, ahead, inside, near** and **towards** were not encountered. Some students used “**in front**” to indicate every position or direction without a reference point. The following sentence illustrates:

7 “...the couple were made to seat *in front beautiful and shiny as gold*”.

This was not surprising given the fact that locating one place or direction relative to another requires the sense of sight.

#### **(b) The sense of hearing**

Words such as **cheering, hooting, shouts, echoes, thunder, silent voice, screaming** and **melodies** were all observed in the students’ compositions. These words were used to

describe the sounds made by people and objects during the wedding ceremony. Here are examples:

8 “... ..allpeople were excited they were **screaming** .....

9 “.....people were mercilessly **cheering** with joy....”

10 “.... a choir of singers were singing their **sweet melodies**”

11 “I heard a **hooting** of a car.....”

The sense of hearing is regarded as the primary sense of the visually impaired according to Landau and Gleitman (2009 and Heward (1996). However, the lexical density scored is far below the expected input because it is assumed that when the sense of sight is impaired, that of hearing takes over the slot reserved for vision in the brain. As stated earlier in the literature review, vision provides approximately 80% of the information to the brain (Heward, 1996). Accordingly, the sense of hearing should have had a higher incidence than what was observed.

A possible explanation for the above phenomenon is that, in some cases, one needs to see the objects or people in order to associate them with certain sounds. It was impossible for the visually impaired to do so because of their visual status, which restricts their experience of the visual environment.

From this study, it is clear that for the visually impaired students, the sense of hearing cannot fully compensate for the loss of visual information. This is because as stated by Bishop (2004), the sense of hearing does not have the same motivational power as the sense of sight does.

### (c) The Sense of touch

Words and expressions such as **bright, nylon, fried by the sun, hot, cold, shade, mud** and **thick carpet** were present in the compositions. The words were used to describe the weather, temperature and texture of people or objects as illustrated in the following examples:

12 “... they were glad to be in **shade** because it is **so hot**.

13 “The sun was **bright** so there was a need of a big sheet of **nylon** to be spread above to protect the people from the sun.....”

14 “There was **a thick carpet** on the floor....”

However, some of the terms were inappropriately used. For instance, ‘nylon’ was used to mean ‘polythene’ and ‘bright’ to mean ‘hot’ when describing the heat from the sun.

Visually impaired people mainly depend on hearing and touch to describe their environment. Some textures need not be touched in order to be described. For example, one can distinguish between a rough and smooth surface merely by the sense of sight. Further on, vision can motivate individuals to see what to hear or touch. Indeed, it is not practical for individuals to go round touching every object or entity they encounter in order to describe its texture. Moreover, some things are inaccessible to touch because they are either small or fragile. So, because of their state, the visually impaired students could not augment the sense of touch with the sense of sight.

#### **(d) The sense of smell**

Descriptive words such as **aroma, delicious, and sweet smelling** were used in their compositions. The words described the smells at the wedding scene as seen in the following examples:

15 “.....some *beautiful smelling flowers*.....”

16 “.....were given *delicious food*”

17 “*Sweet smelling food*.....”

A possible explanation for the low lexical density is that lack of sight limited their movement in an unfamiliar environment, thus reducing the opportunities to smell a variety of things and people in different places at the wedding. The sense of sight also reinforces this sense. For instance, on seeing a carcass, one can imagine a foul smell even before one perceiving it.

#### **(e) The sense of taste**

Descriptive words appealing to the sense of taste such as **tasted sweet, fried, tasted like honey, flavor and delicious** were noted in the examples below:

18 “...we were given cakes which *tasted like honey*.”

19 “...we were given *delicious food*.”

20 “.....*thing become sweeter towards the sweetness of honey*.”

The students scored low here because possibly because there are only a few things that can be perceived by taste. Again, probably the sense of sight can reinforce the sense of

taste. It is possible to see something and say “it looks delicious”.

From the foregoing analysis, it is evident that visually impaired students used very few descriptive terms - actually some had none. The students had important events in their compositions summarized in one paragraph. Again, some of them had sentences that were not meaningful because they left out vital details as in example 7 above.

Although both narrative and descriptive compositions appear in the KCSE English examination, the sighted students have an advantage because they can easily choose either. However, the majority of the visually impaired them opt for a narrative composition one due to lack of descriptive words. Their teachers reported that this is common practice. Even though narrative compositions have some descriptive features, the focus in these essays is to tell about events in the order in which they occurred (Kinneavy, 2001: Langan, 2008: Norton, 2003 and Kirszner, 2008).

Due to their restricted experience of the world, the visually impaired find it difficult to conceptualize and hence describe certain concepts such as colour, movement, space, size and shape. These concepts cannot be heard, smelt or touched. The teachers interviewed confirmed that conceptualization of abstract things is the key challenge to the students. This explains why, according to the teachers, they prefer narrative essays to descriptive ones and perform better in them. It was also revealed that they try as much as possible to avoid descriptive topics whenever they encounter them.

The teachers also said that the students prefer describing people to events and objects. The reason could be that they are always in contact with people and so they are motivated to describe them. The order of senses in terms of frequency in the study data corresponded to what the teachers’ said they had observed: hearing, touch, smell, taste and sight.

## **5.4 Descriptive Characteristics of the English Compositions of Sighted Students**

### **(a) The sense of sight**

The study revealed that the students used descriptive words and phrases relating to colour, size, shape, location and movement. Examples of such included **red, white, glittering, strolled, gorgeous, tall, diamond, behind and peeped** as in

21 *“.....red and white balloons decorated the church.”*

22 "...and then we saw their *shining* and *glittering* clothes."

23 "Her *diamond* necklace *shone* in a *bewitching* manner."

24 "The bridegroom was *tall, slender* of *about thirty five* years".

Most descriptive words came from adjectives and actions verbs such as **marching, waving, smiling, and kissing**. The words were used to describe the people and objects at the wedding as seen in the examples below:

25 *The crowd was **waving** at the bride and bridegroom as they were **marching** towards...*

26 *The couple **kissed** each other before the audience*

The sighted students were able to use many sight descriptive words and phrases because of their ability to see. Wortman (1992) points out that vision is the richest of the human senses and because of this, peoples' eyes receive light from the surrounding objects and translate it into nerve impulses. He further says that when they reach their destinations people experience the vast array of shapes, colour, textures and movements that make their visual world.

### **(b) The sense of hearing**

This was the second in ranking from the study corpora which comprised descriptive words such as **cheering, hooting, screaming, ululations, thunderously, bang** and **murmuring**. They were used to describe the sounds made by people and objects at the wedding. Probably because the sighted students have learnt to associate what they see with certain sounds, they were able to use the following lexical items in their essays:

27 *...**murmurs** rented the air..*

28 *.....the vehicles **hooting** melodiously*

29 *.....**ululations** were sang by old woman.*

The sense of sight can be said to reinforce the perception of bang, cheering and even murmuring since one can see the attendant action.

### **(c) The sense of touch**

It recorded descriptive words relating to temperature and textures of people, objects and situations at the wedding. Descriptive words such as **hot, cool, leather, chilly, smooth,**

**breezy** and **cotton** were noted. See the examples below:

30 *I took a **cold shower** that left me.....*

31 *The bride wore a **crisp cotton** dress.*

32 *The morning was **chilly**.....*

Example 31 was probably aided by the sense of sight.

#### **(d) The sense of smell**

Descriptive words in this sensory input included details connected with the smells of food, the air, the drinks and the environment as a whole. Words such as **scent**, **delicious**, **aroma**, **fresh**, **pungent** and **odour** were all evident in the students' compositions. Here are extracts from the compositions:

33 *I could **smell** the **scent** of perfumes they had applied.*

34 *I took a cold shower that left me **as fresh as daisy**.*

35 *.....**sweet aroma** that come from the food.....*

The channel scored low possibly they are a few things that can be perceived by smell. Example 34 is closely associated with sight since one has to see the source of the fresh smell- in this case a daisy. It is even possible that upon seeing food at a distance, one can begin imagining a sweet smell, something that the visually impaired cannot do. Again, since the sighted are not limited in their movement, they are more likely to move around and perceive different smells such as aroma of food (example 35).

#### **(e) The sense of taste**

This was the lowest ranked in the sensory word bank of descriptive lexical units. The words included **sweet**, **mouth-watering**, **tasty**, **pungent**, **delicious** and **flavor** as seen in the examples below:

36 *The food **tasted delicious***

37 *.... also **the flavor** of food which was already packed in hot dishes.*

38 *.....the food that was **tasty***

An interesting observation is that the sense of taste is the least used by both categories of students. A possible explanation is that there are only a few things that can be tasted. Responses from the teachers confirmed what was observed in this study -that sensory impressions occur in the following order: sight, hearing, touch, smell and taste.

From their compositions, it was clear that sighted students generally exhibited the ability

to explore and interact with the people, objects and actions at the wedding. This enabled them to link descriptive words with their referents correctly. They were also able to easily conceptualize of concepts of colour, weight, shape, size, space and movement because they are sighted.

## **5.5 Conclusion and Recommendations**

The findings in this paper revealed that the visually impaired students have a narrower choice when it comes to selecting a composition topic. This is because they tend to settle for a narrative rather than a descriptive topic. Those who go for the descriptive composition are further disadvantaged since they have fewer descriptive terms in all the sensory channels than their sighted counterparts. Concepts such as colour, movement, direction, space, shape and size are difficult to conceptualize hence difficult to describe given that they are largely dependent on the sense of sight. Thus the claim that the visually impaired students are restricted in their range of descriptions is justified. On the contrary, sighted students used a range of descriptive words in their compositions. We have argued that even the other senses are sometimes fed by sight so that for example, one imagines that the food tastes or smells as good as it looks. For this reason, the study concluded that the visually impaired students are disadvantaged in descriptive writing because, for one to write a good description the brain combines the visual images with the input from the other senses.

The paper therefore made the following recommendations:

- Kenya National Examination Council to consider the needs of visually impaired learners as it sets an English examination that requires descriptive details. It should offer a wide range of topics for the students to choose from.
- The teachers of English to offer a variety of first-hand experiences to the visually impaired students. Furthermore, they (teachers) should deliberately present as many descriptive concepts in class as possible. This will enable the students have a variety of descriptive concepts so that they will use the same in descriptive.
- The school to consider admitting sighted students to learn together with the visually impaired for more linguistic input. The visually impaired may learn more descriptive units from there sighted counterparts in non-formal and informal

settings because communication here is natural and spontaneous.

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## **After Negative Ethnicity: The Future Of Voting In Kenya**

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### **ABSTRACT**

More than any other demographic, the question of negative ethnicity has been a scourge on the African continent. In Kenya, the ethnicisation of politics has plagued the nation since it gained its independence from the British. Ethno-politics persisted and reached its zenith in the 2007 post-election violence which left more than 1000 people dead. This paper interrogates ethnicity's ties to geography; the power inhering in its situatedness. Using Appadurai's concept of 'deterritorialization' and Appiah's 'cosmopolitanism' the paper problematizes the idea that the space within ethnic boundaries is home in a bid to illustrate how the more open, transferable concept "good place that is no place" of Utopianism can help Kenyans detach from a localization. The adoption of this concept as a frame of reference would then disrupt the ethnic voting patterns of ethno-politics and finally usher in the age of voting based on issues and ideas.

Keywords: Utopianism, Negative Ethnicity, Cosmopolitanism, Kenya Elections, Thomas More, Deterritorialization

### **INTRODUCTION**

The identity of Kenyans is fundamentally ethnic. It manifests itself every 5 years during elections and has remained static despite our changing world. The shared space available where the different ethnic groups can interact and establish social relationships is scarce. Instead, they are content to live within their own individual ethnic boundaries. Though this retreat to our homelands conveys well-meaning solidarity with our ethnicity, it inevitably leads to negative ethnicity. Kenyans are happy to be associated with their ethnicities before anything else and the powerful social processes have proved feeble to

maintain, modify or even reshape it as they are wont (Searle 1995). A state mired in negative ethnicity, with little room for modification or reshaping of identity, will ever be divided; it cannot work toward a common objective that benefits all, and has as its fate turbulent election seasons.

The purpose of this paper is to interrogate ethnicity's ties to geography in the Kenyan context and how this leads to negative ethnicity as evidenced particularly by the 2007 post-election violence. It is in five parts. The first part offers an overview of the 2007 election violence paying attention to the function of ethnic boundaries. The second explores the origins of negative ethnicity; it bases it in ethnicity's penchant for attachment, more so its attachment to specific geographic boundaries. In the second it problematizes these ethnic boundaries through the lens of contemporary theories of movement: deterritorialization and cosmopolitanism. The third part brings in utopianism in a bid to offer an alternative to geographical attachment. In the literary genre established by Thomas More (1516/2003), Utopia is a 'good place that is no place', in other words, it is a detached and preserving space. The final part contains brief concluding remarks about utopianism and its prospects for the future of voting in Kenya.

#### An Overview of the 2007 Post-election Violence

Over the years, Kenya's ethno-politics have included the strategy of multi-party coalitions. Two or more political parties, also largely based on ethnicity, merge toward a shared goal. During the 2007 elections the two main competitors were the Orange Democratic Movement (ODM) and the Party of National Unity (PNU). The latter was a coalition of KANU, Ford-Kenya, Ford-People, Democratic Party and others, and its stronghold was among the Kikuyu Central region of Kenya. Whereas ODM's support was focused in Luo Nyanza and also in the Rift Valley owing to the presence of the Kalenjin politician, William Ruto.

Consequently, when the violence erupted it pitted, primarily, the Kikuyu against the Kalenjin and Luos. The two latter groups, including the Luhya who had supported ODM, attacked suspected PNU supporters who inhabited the ethnic boundaries of the ODM supporters, such as Eldoret—a significant city in what is now Uasin Ngishu County, both politically and economically. In the rift valley, the pieces of land owned by the 'foreign' Kikuyu were expropriated by the 'local'. There was also mass vandalism of

their property, and burning of crops in the field. One cannot forget the mass death by burning inflicted on the 35 women, children and the disabled who had sought refuge in the Kenya Assemblies of God (KAG) church in Kiambaa, Eldoret (Kigumba 2011). In Central Kenya, the land of the Gikuyu, “ethnic militias threatened to bum down the Tigoni holding centre, one of the many centers hosting an estimated total of 8,889 non-Kikuyu IDPs across central Kenya and Nairobi” (Kigumba 2011:78) as the Gikuyu sought to expunge Luo and kalenjin from their ethnic boundaries.

Foucault (1967/1984:4) referred to these types of places: the church, the police station, among others where people sought refuge as “crisis heterotopias” because they were “reserved for individuals who are, in relation to society and to the human environment in which they live, in a state of crisis.” It is worth noting that, according to Foucault, crisis heterotopias are exclusive to primitive societies (Foucault 1967/1984). Regardless, ethnic conflict affect neighboring states, poses a threat to both regional and global security and stability, and emerges as a key concern for policymakers. Indeed, ethnic conflict has been elevated to the domain of high politics, a realm previously occupied by international crisis, ideological conflict, and interstate war. (Kigumba 2011: 6).

In any case, it would be erroneous to claim that the violence was clearly delineated in terms of who was fighting against whom. This is because political associations were not as rigid as the ethnic associations. The individual ethnic groups put their needs before those of the political parties. As Kigumba states, “There were also reports of attacks on the Luo and Kisii settlers by the Kalenjin taking advantage of the collapse of law and order to rustle animals and take land from their neighbours irrespective of political loyalties (2011: 78).

Following the promulgation of a new constitution the elections held in March, 2013 demonstrated that political coalitions based in inter-ethnic affiliations are temporary owing to the power of shared ethnicity. In said elections, 5 years after the post-election violence, political associations had altered drastically. Ruto, formerly of Orange Democratic Movement had joined with The National Alliance’s Uhuru Kenyatta and others to form the Jubilee Party. Ford-Kenya under the leadership of Moses Wetangula switched allegiances from PNU to form Coalition for Reforms and Democracy (CORD)

with ODM and others. Also, Kalonzo Musyoka, formerly presidential candidate of ODM-Kenya was now Raila Odinga's running mate, representing the Wiper Democratic Movement. The states of affairs remained constant, more or less, in the 2017 elections but will change inevitably in 2022.

### The Roots of Kenya's Negative Ethnicity

In her study of the role of ethnicity in Kenya's post-election violence, Kigumba (2011) writes:

Ethnicity is the essential bond that unites kinship weaves through the social fabric, in the sense that, ethnic group identities flow from an extended kinship bond, sharing common behaviors and transmitting across generations. In Kenya these bonds date back to even pre-colonial times but were made more evident by the British colonial masters (84).

These bonds are apparent during presidential elections; none more telling than the disputed one of 2007 that ended in ethnic violence. However, it is not only in Kenya that we find issues of ethnicity. As Wolff (2006:64) states, "ethnicity is a fact of life almost everywhere". In addition, the prevalence of multiple ethnic groups in a particular geographical area does not automatically lead to ethnic conflict. Despite ethnic identities being thought to be fluid across time and social contexts, even leading to the transfer of the feature of one ethnic group to another (Alba, 1990; Nagel 1995), the longstanding bonds of ethnic kinship among Kenyans are far from being broken. If anything, the bonds among members of a similar ethnic group lead to a perpetual ethnic isolationism. This, in turn, devolves into negative ethnicity.

There is glaring scarcity of inter-ethnic interaction in Kenya, more so within the purported 'ethnic boundaries'. These types of boundaries are, according to Sanders (2002) "patterns of social interaction that give rise to, and subsequently reinforce, in-group members' self-identification and outsiders' confirmation of group distinctions" (327). Sanders' study was on plural societies and his definition of 'ethnic boundaries' attests to this. The definition used in this paper will refer to territorial demarcations—products of British colonialism. The case of Gikuyu land ownership outlined in Facing

Mount Kenya reflects the contemporary problem of ethnic boundaries. Celarent (2010) writes: “The Gikuyu follow a trusteeship model: the current tenant manages the property for past and future generations of his family but is nonetheless the undisputed “owner” of the land in the present” (724).

This generational management of land doubtless reinforces the idea of ethnic boundaries. However, Kenyatta doesn't tell us that the Gikuyu often practiced agriculture in one area until it became infertile or that there was a good deal of tribal movement (Celarent 2010). The fact is there were rampant migrations within Kenya, and settlements were not constant before colonialism. Sometimes there were fewer ethnicities than there are today, sometimes there were more. As Ndege (2009) quoted in Kigumba (2011) intimates, we owe the current stability of ethnic boundaries to colonialism. But we cannot blame them for remaining within and carving our identities out of them. Each ethnic group lives within their ethnic boundaries; which is not to say that there are no geographical locations where inter-ethnic interaction occurs; Nairobi is perhaps the archetype of such a location.

Aside from the capital city and very few others, the majority of spaces all over the country are populated overwhelmingly by a single ethnic group. From the Kaya Kinondo forest at the coast, through the Mount Kenya forest in Central Africa, all the way to the Kakamega forest, physical features have been used as ethnic identifiers since before the colonialists. From the above three one can learn about the Mijikenda, Kikuyu, and Luhya, respectively. It is not only forests which act as geographic boundaries. Lakes Turkana and Victoria are also some of the many physical markers of Kenya's many ethnic groups.

Each group considers the above-mentioned areas to be their home; it is where they have their metaphorical roots, their literal “good place”. In December it is a commonplace to overhear in random conversations across the capital city such keywords as “upcountry”, *ushago* and *nyumbani* all which denote home or homeland. During this period the Luo will travel to Lake Victoria, the Maasai will go back to the Mara, the Kalenjin will go to Sergoit, and the Kamba to Tsavo East. Each person seeks solace from its own within its delineated geographic boundaries. Granted, these are only some of the more known physical features and the ethnic groups are in no way clustered either on or within them.

This essay suggests that this self-imposed exile; the exclusionary identification with space is, finally, responsible for the scourge of negative ethnicity. Attachment to space betrays a lacking openness among the ethnic communities in Kenya which cuts across. This leads to the desire to go “home” of Kenyans which implies an inability to “feel at home” anyplace beyond the limits of our ethnic boundaries. Put another way, it is as though we hold our breath all year long, to breathe at last when we are in the proximities of our roots. As this analogy implies, attachment to a particular space is an injurious and at the same time arrogant, act. This paper will offer as a counter viewpoint the unconstrained freedom to wander of utopianism. But for now let us find out how the attachment philosophy of ethnic boundaries fares when viewed through contemporary theories of mobility in an increasingly globalized world.

#### Ethnic Boundaries in a World without Borders

Late last year, the president of Kenya, Uhuru Kenyatta in a speech at a national holiday addressed the issue of the restrictions of borders to movement among East Africans and Africans in general. It was a bold idea, and he shares it with the AU chairman, Paul Kagame and reflects what is going on in the rest of the world with Europe as the archetype. Some Kenyan citizens lauded the effort while others who were concerned about the ramifications of this to the security of the country were not sure if it was a good idea. This section deals with the problem of boundaries within Kenya, specifically ethnic boundaries. Increasingly, the global cultural economy is tending toward a borderless future. This section therefore assumes that Kenya is a participant in the global cultural economy and uses two global trends to examine whether or not this participation has impacted the people’s views of these boundaries. The two trends are deterritorialization and cosmopolitanism. Let us now turn to the first.

From the proliferation of international trade and human rights activism to the adoption of the Western ideas of democracy and capitalism, globalization is visible in the mechanisms of Kenya. The movement of people and capital is also at an unprecedented level. The former is most perceptible. And where movement of people is not obvious, the apparent immobility ‘is everywhere shot through with the woof of human motion, as more persons and groups deal with the realities of having to move, or with the fantasies of wanting to move’ (Appadurai, 1990: 297).

Appadurai includes the movement of people or ‘ethnoscapes’ among the five dimensions of global cultural flow. The others comprise: mediascapes, technoscapes, finanscapes, and ideoscapes. The multifaceted flow among these five landscapes or “imagined worlds” is what Appadurai refers to as “deterritorialization” and it varies from state to state. This paper will use the term when referencing movement of a particular individual or ethnic group outside their ethnic boundaries to a territory where they are no longer the majority.

This is not to say that there is no movement of the other four dimensions; it is simply to state that in the Kenyan context the movement of people is most prominent than any other. For instance, there can be movement of Gikuyu from Gikuyu land to Kalenjin land for one reason or other. In this new land the Gikuyu, stereotyped as ‘money lovers’, set up entrepreneurial endeavors in Eldoret or establish their own exclusively Gikuyu church. Similarly the Luo stereotyped to love fish, may leave Luo land to work in the Bata shoe factory in Limuru, Kikuyu land, and set up fish markets. The reasons for movement may also be religious: the leadership of a certain denomination may decide to shuffle its clergy thus requiring that a Kisii move to Luhya land. In all this, the ethnicity of the mover remains unchanged.

Deleuze and Guattari (1991/1994) offer a conceptualization of deterritorialization that would prove radical if appropriated in the Kenyan context because of how it imagines the change in form of that which has deterritorialized. For them deterritorialization is always followed by reterritorialization and the thing or feature which undergoes this movement is unrecognizable. They write that from birth the hominid:

Deterritorializes its front paw, wrests it from the earth to turn it into a hand, and reterritorializes it on branches and tools. A stick is, in turn, a deterritorialized branch. We need to see how everyone, at every age, in the smallest things as in the greatest challenges, seeks a territory, tolerates or carries out deterritorializations, and is reterritorialized on almost anything-memory, fetish, or dream (67-68).

Essentially, under this view, the Kikuyu who deterritorializes from Gikuyuland to reterritorialize in Luo land would not be the same person. She or he would not have the same biases and would therefore be free from the plight of negative ethnicity associated with ethnic boundaries.

The reality of deterritorialization in Kenya, however, is that the group which departs from its ethnic boundaries to a different one keeps their original homeland with them. As Wa Wamwere (2010) writes:

When Africans travel to and settle in Europe and America, despite their small numbers, they bring with them the baggage of negative ethnicity. Abroad, ethnic hate continues to weaken Africans by separating them into ethnic enclaves as it has back in Africa. Observing Kenyans abroad, I have noticed that despite their common passports, they travel and settle out of Kenya not as nationals of one country, as Kenyans, but as members of their forty-two respective ethnic communities (27).

In Kenya, where you come from is more useful than where you are going, or where you are currently. Put another way, the past is more revered than both the present and the future, a fact which frustrates the benefits of deterritorialization. When the future is discussed it is in reference to the past: people are buried in the same space where they were born. Increasingly, more and more children are being born in hospitals situated in urban heterogeneous areas but still this has not altered the longstanding trends in voting. Having been socialized by their immediate influences— family and community—they carry on the baton of negative ethnicity.

Though a global phenomenon, deterritorialization has had a difficult time reaching its full potential because it disrupts the concept of “home” which many Kenyans ascribe to; that of home as a space within specific boundaries. As Canclini (1990) writes: “Deterritorialization speaks of the loss of the “natural” relation between culture and the social and geographic territories” (quoted in Hernandez 2002: 93). It is just not powerful enough to put an end to ethnic boundaries. The Kenyan voter may leave his boundaries but he keeps his metaphorical roots intact. Such a person will be hard-pressed to change her voting habit in the new context owing to his or her socialization early in life. This implies that the deterritorialized voter will have first to unlearn the socialization of family before she can open her mind to the socialization of college. The former is invariably more rooted than the latter.

Our homes in *ushago* are fixed in much the same way that the roots of a tree are fixed deep in the ground and deterritorialization endangers that. As Hernandez (2006)

explains:

The ambiguous or ambivalent character of deterritorialiation must not be forgotten, as, while it generates benefits, it also produces evident costs such as feelings of existential vulnerability or of cultural rootlessness, especially if you consider that individuals have ties to a locality, and this locality remains important for them (94).

One way to grapple with this state of affairs has to do with understanding the psychology of the ethno-political voter. How does one explain how a politician can go for long without visiting his or her homeland without compromising his or her votes? Moreover, how is it that politicians can underperform, get involved in scandals, or do absolutely nothing by way of developing their homeland and still get voted in? It is to these questions that we now turn in light of cosmopolitanism.

From the cosmopolitan rights of dissident writers and political activists as illustrated in Derrida (2001) to a study of Barack Obama as a cosmopolitan Werbner (2012), the reaches of cosmopolitanism have expanded so that it no longer necessitates investigation in the limited sense of international boundaries. In the Kenyan context the most evident form of cosmopolitanism concerns the concentration of multiple ethnic communities in a particular space so that a city like Nakuru acquires the qualifier. But as Keguro (2008) writes, this form of cosmopolitanism proved a weakness during post-election violence.

Presently, with ethnic divisions and the concomitant talks of cessation, a cosmopolitanism that focuses on 'the other' is relevant or as Papastephanou (2009) states: 'Cosmopolitanism is more than just free circulation; it is not just about the encounter or agreement with the other, it is about the treatment of the other' (19). It is for that reason that this paper employs the cosmopolitan ideas of the ethicist, Kwame Appiah (2007). In this section the paper examines the problem of ethnic boundaries within the definitions of Appiah's cosmopolitanism.

Kenya's ethnic divisions are often blamed on a lack of sincere dialogue among different ethnic groups which an engagement with cosmopolitanism should be able to remedy. Cosmopolitanism believes that through the avenue of conversation "you can learn from people with different, even incompatible, ideas from your own" (Appiah

2007:2378). Cosmopolitanism requires openness to ideas and people. In this it is similar to deterritorialization. It does not seek shelter within ethnic boundaries or ethnic narratives; it is not about, as Fine and Boon (2007) in Krossa (2012) write: “cosiness or the warmth of intimate community but rather about the risks involved in disclosing oneself publicly in the world...Cosmopolitanism is a demanding and difficult way of life” (9). This difficult way of life would in turn prove a demanding philosophy because of the regrettable state of the ethno-political voter

As in a mob, the person whose identity is fundamentally ethnic is overrun by this collective of people so that in the end she loses her individuality and becomes an uncritical voter. However, cosmopolitanism acknowledges difference, and one would add, differentiation, even as it recognizes universality of people. According to this concept, “each human individual is charged with ultimate responsibility for his or her own life” and in the end, “the standard that determines whether I am doing well, whether I am flourishing, is, in part, set by aims that I define for myself” (Appiah 2007:2380). Within ethnic boundaries, oppressive unity abounds: the struggling grocer agrees with the wealthy doctor about whom to vote for. The jobless youth pledge allegiance to the same politician as do the well-to-do businessmen. In a sense, ethnic identification requires self-abnegation and even to a more extreme extent, self-erasure.

In addition to liberating the individual from the group, through its respect for diversity of culture, cosmopolitanism helps us get out of our ethnic cocoons. In Kenya, the post-election violence and other recurrent violence such as that in Laikipia County and the Mt. Elgon area reveal a certain hierarchy among the priorities of an ethnic group. It is that: local cultures matter primarily, next, people of shared culture matter, and finally cultures and people of other ethnicities matter the least. However, cosmopolitanism believes that “cultures do not matter in themselves, but because people matter and culture matters to people” (2379). As a result, the harmful aspects of ethnicity such as the propensity to negative ethnicity and wholesale disregard for life are disturbed even as the beneficial actions such as transculturation are encouraged.

All the above mentioned positive outcomes of cosmopolitanism remain unrealizable and negative ethnicity persists because while at the core of cosmopolitanism is the “recognition that we may be mistaken even when we have looked carefully at the

evidence and applied our highest mental capacities” (Appiah 2007) those individuals steeped in ethnic biases do not consider themselves fallible. They are first ensnared and blinded by their ethnic loyalties so that they are convinced that no truth can come out of a rival ethnic group. In a globalized world, where interaction among people of all ethnic groups and religions dominate, “the recognition of the shortcomings our human capacity to grasp the truth” (Appiah 2007) is an invaluable one which the tribal individuals flout. For them winning the contest is more important than the truth.

Another explanation for why negative ethnicity trounces the good will of cosmopolitanism is found in the power inhering in ethnicity’s situatedness in a particular geography. As was stated of deterritorialization, this is also of the things cosmopolitanism would have to contend with if it is to replace the deep-seated idea of ethnic boundaries. Both cosmopolitanism’s regard for ‘the other’ and its affinity for movement have to be seen to be more beneficial to the individual than his or her ethnicity and homeland because it is out of these that negative ethnicity emanates. And when ethnicity degenerates thus it subjugates all other associations cosmopolitanism pays obeisance. As Kamaara (2010) writes:

During the period preceding the 2007 national elections which culminated in violence, the Roman Catholic church in Luo Nyanza was on one end of the political divide while the Roman Catholic church in Gikuyu land was on the extreme side...Thus political polarization became synonymous with Christian polarization (136).

So far ethnic boundaries are still very influential in Kenya and ethnicity remains the fundamental identity. It would seem, therefore, that either the project of cosmopolitanism has failed or it has yet to reach a point where it can challenge Kenya’s ethnic boundaries effectively. Otherwise, perhaps one need not replace the other; there could be a way to reconcile the program of cosmopolitanism with Kenyans’ concerns for ethnic boundaries. It is with this in mind that we turn to our discussion on utopianism.

The term “utopia” was coined by Thomas More (1516/2003) but the concept appears as early as 380 BC in Plato’s Republic. The concept has been theorized for centuries and may be theorized for centuries more. Among realists and anti-utopians, all this appears a waste of time, resources and faculties. For them utopia is merely wishful

thinking, an unrealizable dream. As Papastephanou (2009) astutely points out:

For most lay people, the utopian is equated with the unrealizable, the impossible in principle, or the impossible for most human beings over which one should not waste time or energy. Apart from being presented as futile, the utopian has been accused of having pernicious political implications (3).

The aim of this section is not to start a polemic against the critics of utopianism; rather it is to illustrate how the concept may be the solution to the problem of ethnic boundaries which remains challenging in the face of globalization. We begin with some pertinent views of utopia.

For Mannheim (1936), it was necessary for utopia to take on a revolutionary function and effect change in the present Social conditions and Bloch (1954/1986) wrote voluminous and convincingly of the pervasive nature of the utopian. Such conceptualizations of utopia present a challenge to common conceptions of it as not only forever unrealizable but also as limited to the imagination. Utopianism challenges the status quo; it is subversive. And this is what is needed in Kenya currently with the problem of negative ethnicity and ethno-politics. There is need to think beyond the present state of affairs, to outline a better future. Only then can we, in the words of Geoghegan (2008), “undermine the complacency and overcome the inertia of [the current society] by showing that it is neither eternal nor archetypal but merely one form amongst many” (16). But what exactly are these concerns that necessitate the need for utopianism as alternative?

As the paper has described in the previous sections, there is among the Kenyan ethnicities a tendency to consider a specific geographical space as home which leads to a feeling of homelessness in all other spaces. We have seen how this manner of thinking leads to negative ethnicity. For instance a Maasai may feel at home in Narok but homeless in Isiolo. While in Isiolo, he longs for Narok or in other words, feels homesick for Narok. If he stays outside Narok long enough he may become nostalgic for it. According to Coleman (2005):

The Swiss-German ‘heimweh’ or homesickness is the original meaning of nostalgia. Taken together, these terms denote an intense longing for (a) home. Constructed homes can be as much the locus of nostalgia as is the land of their

location. Home and land are idealized through the longing for them (26).

Within Kenya's different ethnic boundaries, constructed homes or houses of various forms are in plenty but this is not the provision for one to refer to such spaces as home. For instance, children who still live under their parents' roofs are encouraged to consider these as their homes. Another common occurrence is that of parents proffering to their children pieces of land on which to build their own houses. In such an instance the piece of land is metonymic for a house and of course, a home. This concern of attachment to space though it begins harmlessly as ethnic identification leads to negative ethnicity and therefore requires an alternative.

More's (1516/2003) term 'utopia' was a result of a play on two Greek words so that utopia is the good place 'eutopos' that is no place 'outopos'. In utopianism, location is immaterial; what is important is the quality of the place. The idea of a home in a particular space acts as the sole good place for many Kenyans but utopianism seeks to expand this view. It assumes that a good place can be found anywhere and encourages the search for such a place. Kenyans' reverence for the past plays a part in the attachment to physical space. Rather than promote fluid concept of the 'no place' among ethnic groups, it keeps the groups bound within the same boundaries. This in turn stifles thoughts of the future, thoughts about what society is capable of becoming. As Quarta (1996) explains, "to exist in no place, in truth, belongs to the projective, since this latter, if it did have a place, if it were already realized, would no longer be projective" (155).

The concept of the 'no place' may convince people to migrate freely out of their ethnic cocoons but can it settle the recursive problem of roots? This paper has already addressed the cases of the deterritorialized voters who seem to figuratively carry their roots with them to their new spaces. These people, when they are of voting age, retain their ethnic biases; it is difficult to change their minds. In utopianism, the 'outopia' goes hand in hand with the 'eutopia', the 'no place' and the 'good place' follow each other necessarily. The individual who moves from his homeland is keen to find a place just as good if not better than where he comes. We have already established the reasons why the movers are disinclined to change their old habits: mob mentality, credulity and socialization; all which are related to negative ethnicity.

Unlike negative ethnicity, utopianism is concerned with the individual, first and

foremost. Thus, the good place ought to be where the individual feels liberated from the mob; anywhere he or she can exert him or herself free from exteriorities. The individual is free to think for herself and is improved “ethically in accordance with his or her both recognizable and malleable human nature and the pursuit of political ideals, such as freedom, justice, and the absence of social conflict” (Cojoracu 2012:47).

Ideological discourse finds audience in utopianism so that a poor voter and a rich voter cannot share a political candidate on superficial terms as ethnic identity, no matter how fundamental it may be. Utopianism ensures that the voter is critical and knowledgeable, considering everything about the candidate: values, morals, beliefs, before voting them in. The effects of socialization are also counteracted because the utopian anthropological assumptions recognize “the priority of egoism over altruism” (Papastephanou 2009: 7). The voter is no longer there for sale to the highest bidder; nor is her vote to a member of her clan assured.

Once the age of elections based on ideas on issues is initiated through utopianism, conflicts which accompany elections will likely come to an end because, at least in Kenya, they are ethnically instigated. Even as it keeps the individual at its centre, utopianism recognizes the dignity of the other. In More (1516/2003), “the utopians think...that no one should be considered an enemy who has done no harm, that the kinship of nature is as good as a treaty, and that men are united more firmly by good will than by pacts, by their hearts than by their words” (84-85). The only harm most of the victims of the 2007 post-election violence had done was being born of a different ethnicity. Slashing a neighbor with a machete is no way to treat the other. We should emulate the inhabitants of *Utopia* and be open-minded in our relations with the other. Further, as Navaud (2016) reminds us of utopians, we should be curious and humble enough to learn whatever we can from our neighbors even as they learn from us.

## CONCLUSION

Kenya was a multi-ethnic country long before the European set foot on the continent of Africa. Interaction among them by way of trade, wars, and marriage influenced the material of individual cultures and continues to do so albeit in a minimal capacity. When the British drew borders throughout the country, families, clans and tribes

were separated; but the larger body of ethnicity was not affected much. In fact, ethnicity became a primary means of identification and it was situated in a specific geographical spaces. These spaces were home and they were metonymies of ethnicity. Eventually, this attachment to space leads to negative ethnicity and was responsible for the 2007 post-election violence. Though largely absent year round in social and economic interactions, the power of ethnicity is paraded in Kenya during the election season and this has brought about the current ethno-politics.

Violence over the outcome of an election is completely unacceptable and should be prevented through encouragement of intermingling among the different ethnicities in Kenya. Already the country has experienced considerable deterritorialization or the movement of individual or group out of their ethnic boundaries to a place where they are no longer the majority but this has been futile in eradicating negative ethnicity because the people are unwilling to change their outlook in the new land. The voters who migrate from their homes to other territories maintain their biases of ethno-politics which frustrates the aim of deterritorialization.

Kenya has also experienced cosmopolitanism in various forms and we have seen that the type advocated for in this article, the type that is concerned about the other, is still unable to free Kenyans from the captivation they have with ethnic boundaries. Even when they are born in cities where the different ethnic groups interact, the individual acts in accordance with the behavior of the people most responsible for her socialization. The metaphoric roots of ethnicity transcend ethnic boundaries and the fear of rootlessness ensures that people maintain some level of connection even in their spatial disconnection.

The perspective of utopianism offers an alternative to the tendency of Kenyans to base their identity on ethnicity in an effort to end negative ethnicity. Negative ethnicity is more concerned about the group whereas utopianism caters for the desires of the individual. The goal of utopianism is to enable the individual to be free to wander, free to uproot and replant elsewhere. It encourages the voter to think about his own interests before casting a vote for a politician and preserves him when he leaves the comfort of solidarity with fellow ethnic affiliates.

In More (1516/2003) we read of the utopian spirit that compelled the young Hythloday to give his possessions to his relatives and travel the world (50-51). If it were

not for his selflessness we would have never heard of this commonwealth. Utopia teaches one to be comfortable anywhere, not to let any one place stand out among others. It demystifies the attachment to homelands and thus pre-empts a future of negative ethnicity.

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**Taswira ya Gereza katika Riwaya ya *Haini* (Shafi Adam Shafi): Uhakiki wa Ki-foucault**

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**IKISIRI**

Makala hii inakusudiwa kutalii jinsi gereza ilivyotumiwa kama msingi wa kuendeleza maudhui katika riwaya ya *Haini* ya Shafi Adam Shafi. Aidha, inapania kudhihirisha jinsi maudhui ya jamii ya kigereza yanavyobainika kuambatana na sifa zinazotambuliwa na Michael Foucault ambaye ni mwasisi wa nadharia ya Ki-Foucault inayoongoza uhakiki huu. Aghalabu msanii wa fasihi huchota malighafi yake kutokana na jamii anamokulia pamoja na tajriba yake inayoongozwa na ubunifu wake. Pia, matukio na asasi mbalimbali za jamii hutoa mchango mkubwa katika kuendeleza maudhui katika fasihi ya Kiswahili. Gereza ni mojawapo ya asasi zinazokuwa chemichemi ya maudhui yanayoendeleza fasihi katika jamii. Maudhui ni kipengele muhimu katika kazi ya fasihi, yanapofanuliwa na kueleweka na msomaji, hapo ndipo lengo la mwandishi hukamilika. Katika msingi huu tumedhamiria kuchunguza jukumu la mfumo wa kigereza na athari zake katika jamii kwa kurejerea *Haini*.

**Utangulizi**

Uhakiki wetu unaongozwa na nadharia ya Uhakiki wa Ki-Foucault. Nadharia hii, inahusishwa na Michel Foucault (1926 – 1984), msomi wa Kifaransa ambaye mawazo yake yamekuwa na athari kubwa katika taaluma mbalimbali. Mihimili mikuu ya nadharia hii ni masuala ya nguvu, maarifa, adhabu, sheria, uchungulizi, kudhibiti na gereza.

Foucault anaonyesha jinsi watu wanavyodhibitiwa na nguvu katika jamii. Anamwona

binadamu kama kiumbe asiyekuwa huru bali kiumbe aliyefungwa pande zote na maamuzi ya kijamii.

Foucault analiangalia kwa jicho pevu suala la adhabu. Anasema kwamba, adhabu inatumiwa katika jamii kuudhibiti umma. Anachunguza kubadilika kwa adhabu kutoka kwa mwili hadi kwa akili. Anachunguza namna adhabu ilivyobadilika kutoka ile ya kunyongwa kwa wahalifu na kuadhibiwa hadi kuwatia watu kifungoni.

Kuhusu gereza, Foucault anasema kwamba, huu ni mfumo wa kuadhibu ambao umeiathiri jamii nzima. Jinsi gereza huwadhibiti wafungwa, ndivyo jamii inavyowadhibiti watu. Watawala hutumia teknolojia ya kisasa na vyombo mbalimbali vya dola katika kudhibiti maisha ya watawaliwa. Maoni yake ni kuwa, jela haikusudiwi kuondoa uhalifu bali kuunda jamii ya watu wanaochukuliwa kuwa wahalifu ambao wamefungwa ili wasiwaathiri wengine.

Kuhusu jamii ya kigereza, Foucault anazungumzia jamii ambamo mfumo wa kigereza umekuwa kanuni kuu katika jamii ya kisasa inayotegemea kwa kiasi kikubwa, udhibiti wa mkondo wa mawazo na maarifa ya wanaotawaliwa na nguvu hiyo. Foucault analinganisha gereza na shule, makao ya wanajeshi na hospitali ambapo mawazo yanadhibitiwa kwa njia moja au nyingine.

Wamitila (2002:172) akiifafanua nadharia hii, anasema kuwa, Foucault anaelekea kuushambulia mwelekeo wa wahakiki wanaotegemea dhamira au lengo la mwandishi kama msingi wa kuzihakiki kazi za fasihi. Badala yake, anawahimiza wahakiki waichunguze mipangilio ya kimaana na ya kitathmini katika kazi za fasihi zinazohusika.

Tumeichagua nadharia hii kwa kuwa vipengele vyake muhimu vinafaa utafiti wetu; kwa sababu, riwaya ya *Haini* imejengwa katika mazingira ya Kigereza nayo mawazo ya Foucault yamejengwa katika misingi ya gereza. Tunaangazia vipengele vyake muhimu na kuonyesha jinsi vinavyodhihirika na kuendelezwa katika *Haini*.

Tunachunguza jinsi suala la nguvu linavyojitokeza katika *Haini*, tunachunguza namna

watawala wavyotumia mamlaka yao na sheria kuukandamiza umma, kwa mujibu wa madai ya Foucault. Nadharia hii imetusaidia kuchunguza jinsi wahalifu huadhibiwa katika jamii anayoiandikia mwandishi na kwa jumla, imetusaidia kuchunguza iwapo jamii anayoiandikia mwandishi ni jamii yenye mwelekeo wa Kigereza.

### **Maelezo ya Istilahi**

1. Tumetumia istilahi hii ya fasihi ya magharibi, kumaanisha fasihi yoyote ile iliyoandikwa nje ya bara la Afrika.
2. Enzi ya mateso, inavyoelezwa na Foucault, inarejelea karne ya 18 kule Ulaya wakati washukiwa na uhalifu waliadhibiwa hadharani. Katika *Discipline and Punish* (1977), Foucault ameanza kwa kueleza jinsi washukiwa walivyoteswa hadharani.
3. Foucault anaieleza adhabu ya kimwili kuwa ni mateso. Nayo adhabu ya kiakili, ni adhabu inayotokana na kudhibitiwa kwa watu, hivyo ni akili inayoadhibiwa.

### **Gereza na Jamii ya Kigereza.**

Gereza ni moja ya mbinu kuu za kuadhibu inayotumiwa ulimwenguni kote. Kila siku, vyombo vya habari kote ulimwenguni hutoa habari inayohusu uhalifu na kifungo. Kazi za fasihi ya kifungoni zimejaa masimulizi kuhusu hali na maisha ya gerezani.

*Encyclopedia Americana* (1977:619: Juzuu 22) inaeleza gereza kuwa ni mahali washukiwa wa uhalifu wanamofungiwa wakingoja kufikishwa mahakamani, au ni mahali wahalifu hufungiwa kama njia ya kuwadhibu. Katika historia ya binadamu, jela zimekuwepo tangu azali, zamani zikitumiwa tu kama mahali pa kuwafungia washukiwa wakingoja hukumu. Matumizi ya jela kama njia ya kuadhibu wafungwa si jambo lililo na historia ndefu. Katika Ulaya na Marekani, jela zilianza kutumiwa rasmi kama njia ya kuadhibu mnamo miaka ya mwanzo ya karne ya 19.

Kwa mujibu wa Ensiklopedia hii, jela hutekeleza majukumu matatu makuu: kuadhibu, kufungia na kudhibiti. Wahalifu au washukiwa wa uhalifu hufungiwa kama njia ya kuwadhibu na wakati huo huo huwa ni njia ya kuwadhibiti. Ensiklopedia hii inadokeza

kuwa, jela ni kioo cha ulimwengu na wa nje (jamii iliyo nje ya gereza), kwa kiasi.

Encyclopedia, *New Universal Library* (1967:193 vol 11) inaafikiana na *Encyclopedia Americana (k.h.j.)* kuhusu fasiri ya gereza. Inaeleza kuwa, watawala wamezidumisha jela tangu zamani zikiwa mahali pa kuwafungia washukiwa wakingojea hukumu. Jambo lililo wazi ni kuwa, katika ulimwengu wa leo, jela ni mahali pa kuwafungia washukiwa wakingojea hukumu au kama njia ya kuwaadhibu wahalifu. Hili ndilo jukumu tunaloona jela ikitekeleza katika *Haini* na katika kazi nyingine za fasihi ya kifungoni.

Katika *Haini*, Hamza na wenzake wamekamatwa na kurundikwa gerezani. Wanabaki gerezani kwa jumla ya miaka miwili hadi mahakama inapotoa uamuzi kuhusu kuhusika au kutohusika kwao. Hamza na baadhi ya wenzake wanaachiliwa huru kwa ukosefu wa ushahidi wa kuwahusisha na mauaji ya Kigogo. Baadhi ya wale washukiwa wanahukumiwa kifo na wengine wanahukumiwa kifungo cha miaka kumi na mitano kama njia ya kuwaadhibu.

Kwa muhtasari, jamii ya kigereza ni jamii inayolanda gereza kimwelekeo; ni jamii ambamo watawala hutumia uwezo wa dola kwa njia rasmi kudhibiti umma, sheria hutumiwa kwa manfuaa ya wachache, vyombo vya dola hutumiwa kudhibiti na kukandamiza umma; kiuchumi, kijamii na kisiasa umma hufungwa kigereza. Mfumo huu husababisha kujitokeza kwa jamii inayotawaliwa na hofu, usaliti, kutoaminiana, unafiki na mateso ya hali ya juu kwa wanajamii wengi.

### [Historia Fupi ya Zanzibar](#)

Riwaya ya *Haini* pia inaakisi tukio la kihistoria lililohusu kuuawa kwa Rais wa Zanzibar Abeid Amani Karume mnamo mwaka wa 1972. Watu wengi wasiokuwa na hatia walisakwa wa kukamatwa na kutiwa gerezani kwa kutuhumiwa kuwa mahaini. Mwandishi amelitumia tukio hili kuwa kiini cha kuyachunguza matatizo ya kiuchumi, kisiasa na kijamii ya nchi za Kiafrika baada ya uhuru.

Zanzibar ni muungano wa visiwa viwili, Unguja na Pemba, vilivyo mkabala na Tanzania bara katika Bahari Hindi. Data ya historia inaonyesha kwamba, kufikia karne ya 15, Zanzibar ilikuwa kituo muhimu cha kibiashara kati ya Afrika, Mashariki ya Kati na India. Mnamo mwaka 1503, Wareno walivamia Zanzibar na kuanzisha utawala wao huko. Waarabu kutoka Omani waliwaondoa Wareno utawalani mnamo mwaka 1698. Mnamo mwaka 1832, Sultani Sayyid Said wa Omani, aliamisha makao yake makuu hadi Zanzibar. Wakati wa enzi ya ukoloni barani Afrika, mkataba wa Waingereza na Wajerumani wa mwaka 1890 uliifanya Zanzibar koloni la Waingereza lakini ikitawaliwa na Sultani, hali iliyoendelea hadi mwisho wa Vita vya Pili vya Dunia.

Mfumo wa kisiasa na kiuchumi ulioimarishwa na Waarabu nchini Zanzibar, unaweza kuelezwa kuwa ulikuwa na kikabaila. Serikali iliongozwa na sultani na tabaka la watwala ndilo lilimiliki mashamba na watumwa. Kuwepo kwa Waingereza, kulibadilisha mfumo wa kiuchumi kuwa wa kibepari.

Mnamo tarehe 10/12/1963 Uingereza ikaipa Zanzibar Uhuru chini ya uongozi wa Sultani. Kabla ya mapinduzi ya Zanzibar ya mwaka 1964, Zanzibar ilikuwa jamii ya kitabaka; kulikuwa na tabaka la Waafrika maskini waliokuwa wengi; wahindi-wafanyi biashara; na Waarabu-watawala na wamiliki mashamba.

Kiuchumi, Zanzibar ilitegemea ukuzaji wa nazi na karafuu katika mashamba makubwa yaliyomilikiwa na Waarabu. Waafrika walikuwa watumwa na wapagazi katika mashamba haya. Muundo huu wa kitabaka na Kiuchumi uliowanyanyasa waafrika, ndio ulisababisha mapinduzi ya Zanzibar ya mwaka 1964.

Haya ndiyo maudhui yanayotawala katika kazi nyingi za waandishi wa Zanzibar kama vile Mohamed Suleimani Mohamed na Adam Shafi. Katika mapinduzi haya, utawala wa Sultani ulingolewa na waafrika walio wengi, Zanzibar ikawa Jamhuri chini ya uongozi wa Abeid Amani Karume. Katika *Haini*, mwandishi anamulika historia hii ya Zanzibar kutoka mbali anaposawiri sifa za Chopra, mwendesha mashtaka wa serikali. Anasema:

*Jinsi alivyokuwa bingwa wa kazi yake hiyo, aliaminiwa sana na mahasimu wote watatu waliokitawala kisiwa cha Zanzibar. Wakati wa Elizabeth wa pili aliaminiwa sana na watawala wa kiingereza na utiifu wake kwa watawala hao ukawa ni wa kupigiwa mfano. Sultani na wafuasi wake walipofanikiwa kuundoa utawala wa Elizabeth wa pili na kuweka utawala wao, nao pia wakawa na imani kubwa na Chopra wakamfanya kuwa ndiye mshauri wao mkuu wa mambo ya kisheria ...wakwezi na wakulima walipokuja juu wakamtimua Sultani na wafuasi wake kwa mapanga na mashoka na Kigogo akashika usukani wa kuiongoza nchi, Kigogo hakumwona mwanasheria aliyekuwa na kipawa kumshinda Chopra, akampandika cheo cha mwanasheria mkuu wa serikali.*

*(uk 230 – 231)*

Abeid Amani Karume aliuawa mnamo mwaka 1972. Taifa la Zanzibar likashuhudia kilele cha ukiukaji wa haki za kibinadamu katika kile watawala walichokiita ‘usakaji wa mahaini’, wauaji wa Karume. Watu wengi waliteswa, wengi wakauwawa na wengi walifungwa gereza kwa shutuma za kushiriki mauaji ya Karume. Taifa likawa kama gereza. Hili ndilo tukio ambalo mwandishi analimulika katika *Haini*.

Historia hii ya Zanzibar imeonyesha desturi ndefu ya kunyanyaswa kwa umma, katika tawala mbalimbali ambazo zimedhihirisha mfumo wa utawala unaojali maslahi ya watawala wachache, huku watawaliwa walio wengi wakiumia. Ni historia ambayo imedhihirisha matumizi ya nguvu rasmi, katika kuwakandamiza na kuwadhibiti watawaliwa. Hali hii, inaendelezwa katika Zanzibar huru, jamii ambayo Shafi anaizungumzia katika *Haini*.

Maudhui ya jamii ya Kigereza yamesawiriwa katika viwango mbalimbali, katika sura hii tumechunguza viwango vitatu vikuu: **Adhabu, nguvu na uangalizi**. Tumevijadili kwa undani na kuvitolea mifano mwafaka kutoka kazi hii tunaiyoichunguza na aidha kutoka

kwa kazi nyingine ambazo tumeona zinafaa katika kutilia mawazo yetu msisitizo.

### **Udhalimu na Ukatili**

Udhalimu ni tendo la kufanya maovu na aghalabu huhusiana na matendo yasiyokuwa na huruma. Udhalimu uliopo katika jamii anayoizungumzia Adam Shafi unahusishwa na viongozi dhidi ya umma. Mfumo wa kigereza uliokita mizizi katika jamii hii, unatekeleza dhuluma kubwa za kukatisha tamaa. Watawala wanatumia mfumo huu katika kuwakandamiza raia kwa kuwashuku kuwa wahalifu.

Katika *Haini* mbali na kuwa mahaini wanaadhibiwa kwa kufungiwa na kwa hivyo kutenganishwa na maisha huru, wanakabiliwa na mateso na dhuluma za hali ya juu ili waweze kukiri kwamba, walihusika katika mauaji ya Kigogo. Washukiwa wanadhulumiwa kimwili na kisaikolojia. Ukatili huu wanaotendewa wahalifu unatekelezwa kwa sababu ya nguvu rasmi walizonazo watawala. Mfumo wa kijamii hasa kwa kupitia sheria, unawapa watawala nguvu za kuunyanyasa umma kwa ajili ya matakwa na faida yao. Mwandishi amesawiri jinsi wenye mamlaka wanavyotumia vitisho, ila, nguvu, uonevu na dhuluma kuwakandamiza watahumiwa wa uhaini.

Mwandishi amesawiri dhuluma dhidi ya washukiwa wa uhaini kutoka mwanzoni mwa riwaya ambapo tunaona watu wakishikwa ovyo ovyo kwa kutuhumiwa. Wanapelekwa katika kituo cha polisi ambako wanateswa na kupigwa kinyama. Kwa mfano, Hamza anapofikishwa katika Kituo cha Polisi cha Malindi anakaribishwa kwa kofi, pale anapomkuta rafiki yake, Barakati ambaye amepigwa sana, akatiwa pingu na kuvuliwa nguo zote, amepigwa sana kiasi kwamba amepoteza ufahamu wa Kiswahili sasa anaongea Kiingereza tu.

Gerezani washukiwa wanamosokomezwa, wanakandamizwa kwa dhuluma za aina mbalimbali. Tunawaona wanapofikishwa gerezani wote wanavuliwa nguo zao zote wakiwa pamoja, wanaume, wanawake na watoto. Hakika huu ni utovu wa heshima na utu. Viongozi wenye mamlaka wamesahau kwamba hawa ni watu lakini wanawachukulia kama vitu tu bali si binadamu walio na utu na heshima zao. Tunasoma:

*“Vueni nguo!” aliamrisha mmoja wao... na pale alionyesha wazi wazi kuwa yeye ndiye mkubwa na mwenye sauti... Hamza akashangaa, akawatazama wenzake. Akafikiri, watavuaje nguo kwenye mkusanyiko kama ule! “Nasema vueni nguo!” sasa amri ilizidi ukali. Na naam nguo zilivuliwa. Wanaume uchi, wanawake utupu wa mnyama... wale waliokuwa wakiheshimiana, heshima iliishia pale na wale waliokuwa wakistahiana, staha iliishia pale.*

*(uk 10)*

Adam Shafi ameonyesha namna viongozi wanavyotumia nguvu kuwakandamiza watawaliwa na kwa hivyo, kuwadhibiti. Hivi ndivyo nguvu inavyofanya kazi katika jamii kwa mujibu wa nadharia ya Foucault. Lengo kuu la viongozi katika kuwakandamiza raia ni kuwadhibiti. Enrich Fromm katika kitabu chake, *The Heart of Man* anaonyesha lengo la ukandamizaji. Amenukuliwa na Paulo Freire katika *Pedagogy of the Oppressed (1972)* akisema kuwa, ukandamizaji unahusisha kuwadhibiti wanaokandamizwa. Fromm anasema:

Raha iliyopo katika kumkandamiza mtu mwingine ni ukatili tu. Lengo la ukatili ni kumpotezea mtu utu na kumfanya kitu...kwa kuwa kudhibiti mtu kabisa kunampotezea uhuru wake wa kuis (Tafsiri yetu).

Ni katika mkabala huu ambapo Freire anasema kuwa, sifa kuu ya wakandamizaji ni ukatili. Ili kumkandamiza, kumnyima uhuru na kumtawala, mkandamizaji huzuia njia zote za mkandamizwa kujikomboa. Hili ndilo tunaliona katika *Haini* ambapo raia hawana lingine ila kubaki wamedhibitiwa kwa kukandamizwa.

#### **i. Mazingira Dhalilishi**

Mazingira ya vyumba wanamowekwa wafungwa, yanaendeleza picha ya dhuluma dhidi yao. Mfungwa hufungiwa katika chumba akiwa peke yake au katika chumba akiwa

pamoja na wengine. Mshukiwa anapofungiwa katika chumba peke yake kunamdhulumu kisaikolojia kwa kuwa hali hii, inamtenga na binadamu wengine na kumwacha kusononeka kwa upweke. Kwa mfano, Hamza anafungiwa peke yake katika chumba cha kiza. Kuna vyumba ambamo wafungwa waliwekwa kwa makundi, kwa mfano chumba cha akina Hamza, Sururu, Shekhe Mandundu, Shadidi, Kombo, Abdul, Fimbo, Bilali na Nassor kule Kumbakumba.

Mwandishi ametuchorea taswira ya vyumba wanamofungiwa wafungwa na kutuonyesha namna hali yao ilivyodhalilishwa na kudunishwa. Anataeleza kuwa, vilikuwa vyumba vitupu, havikuwa na chochote cha kulalia. Mle ndani mlikuwa na mtondo tu, ambao ulikuwa ndicho choo chao. Je, itakuwaje mtu kukaa chumba kimoja na kinyesi chake? Chumba chenyewe kimezibwa kila mahali! Usiku huminimika mbu vyumbani. Mle ndani mmejaa wadudu wa aina zote wapendao mazingira ya uchafu.

Mazingira ya chumba cha kiza yanadhulumu hata zaidi kuliko vyumba vingine mle Kumbakumba na kwa Ba Mkwe. Baada ya Hamza kukataa ushawishi wa Kanali Bunju na wenzake wa kumtaka akiri kuhusika katika uhaini ili awe shahidi wao mahakamani, Bunju anaagiza Hamza apelekwe katika chumba cha kiza. Chumba hiki anavyokisawiri mwandishi ni chumba cha kudhalilisha sana. Tunasoma:

*Kiko katikati baina ya Kumbakumba, chumba cha kunyongea na jiko. Mlango wake ni wa chuma na jua la mchana kutwa hupiga mlangoni hapo. Ukuta wa chumba hicho umeshikana na jiko na kuni zote zinazoteketea jikoni hapo humimina joto lake ndani ya chumba hicho. Mchanganyiko wa joto la moto wa jikoni na joto la jua linalopiga juu ya ule mlango wa chuma mchana kutwa ndio unaotengeneza hali ya hewa ya chumba cha kiza. Joto kali hufukuta chumbani humo kutwa, kucha na inapofika usiku, mbu humiminika humo utadhani wanamiminiwa makusudi (uk 85).*

Hii ndiyo iliyokuwa hali katika chumba cha kiza. Ilimwia Hamza vigumu kusimama,

kuketi au hata kulala mbali na kuwa katika hali ya upweke na njaa. Anatolewa mle chumbani baada ya siku kumi na mbili huku amezidiwa na homa kali.

Dhuluma dhidi ya washukiwa hazikuisha tu na vyumba vya kumbakumba, kwa Ba Mkwe na Chumba cha Kiza. Kuna Mashakani Hotel.

*“Huku ndiko wanakopelekwa watu wakafichwa kwa miaka kadhaa wasijulikane walipo na hatimaye wakatokomea kabisa” (Uk.168).*

Ni jumba ambalo limefichika katikati ya chaka kubwa. Haramia anapotaka kuwashawishi wenzake wasikubali kuwa mashahidi katika kesi ya uhaini dhidi ya wenzao, huku ndiko anakopelekwa baada ya kusalitiwa na Pwacha. Haramia anafungiwa chumba kimoja na chatu ili yule chatu amle atakapohisi njaa. Ujasiri na mauti yanayomkabili Haramia unamfanya kumenyana na yule chatu na Haramia anafaulu kumwua kwa kumkata shingo kwa meno yake.

Mazingira ya vyumba yanayokandamiza ni jambo linalodhihirika katika kazi nyingi za fasihi ya kifungoni kwa mfano, Kihoro katika *Never Say Die* (1998) anaeleza kwamba wakati mwingine mfungwa alitiwa ndani ya chumba kilichokuwa na maji tele na kuachwa kupoozea mle kwa siku kadhaa. Naye Jackson (1971:8) anaeleza hali ya vyumba vya gereza walimofungiwa wafungwa wenye asili ya Kiafrika kule Marekani. Anasema kuwa, mfungwa alifungiwa katika chumba chenye kiza ambacho sakafu na kuta zake zilizochakaa zilifunika kwa kinyesi cha wafungwa waliokuwamo. Siku saba aliachwa uchi na hakuruhusiwa kuoga. Hakukuwa na chochote mle ndani isipokuwa shimo la choo katika sakafu.

Katika *Haini*, watuhumiwa pia wamenyimwa fursa ya kutekeleza usafi wa mwili. Kuoga na kunyoa nywele ni mambo ambayo yalikuwa nadra mle gerezani. Pamoja na hayo, mavazi yao ni matambara. Mwandishi anapotoa taswira za wafungwa hawa anasema kuwa, ule wasifu wa sura zao za kibinadamu umeanza kupotea, wamekuwa kama hayawani, manywele machafu yamewasimama timutimu, yamesokotana, yameshiba vumbi na kuzongwa na nyusi za magunia. Anaendelea kueleza kuwa, nyuso zao zimesongwa na madevu yaliyoota ovyo ovyo yameshikana na misharabu iliyotambaa juu

ya midomo yao ikatoa miche mithili ya magugu na kuifunika midomo yao. Kinyatti (1996) akigusia tajriba zake gerezani anasema kwamba, wafungwa wengi huvaa matambara yaliyovamiwa na chawa ambayo hunuka kinyesi, si ajabu kuwaona wafungwa wakitembea uchi.

### **Uhaba wa chakula**

Chakula hutumiwa kama mbinu ya kuendeleza dhuluma. Gerezani chakula ni haba pamoja na kuwa hakipikwi vizuri. Watuhumiwa wanateswa kwa kunyimwa chakula kizuri na cha kutosha. Kile kidogo wanachopewa kinachochea njaa badala ya kukidhi haja. Mwandishi anasema kuwa, asubuhi waligawiwa kikopo cha uji na kipande cha muhogo. Mchana, muhogo wa kuponda na majani yake, wakakipa chakula hicho jina la *“full suit”*.

*“Mazungumzo yao yote mle chumbani yakawa juu ya mlo, kula na mipishi. Wakazungumza kula, wakaota kula, wakapika kwa mawazo, lakini wapi, njaa ikawatawala mle gerezani mtindo mmoja”*. (uk 22).

Katika chumba cha kiza Hamza anapewa chakula kidogo sana. Rafikiye, Hamadi Matope ambaye ni mfungwa mpishi, anamfaa kwa kumlisha rojo ya maharagwe iliyochanganywa na wali akitumia mpira wa kumwagia maji bustanini.

Viongozi wanatumia mbinu ya uhaba wa chakula kuwakandamiza washukiwa ili wakiri kwamba, walishiriki katika uhaini. Hamza anaposhawishiwa na Kanali Bunju akiri kushiriki, anaahidiwa kuwekwa mahali pazuri. Mahali wale wengine tisa waliokiri wamewekwa wanapopewa pilau, chai ya maziwa, mikate, siagi na “jam”. Akiwarejelea wale tisa, mwandishi anasema:

*Chumba chao sio cha wale wanaolishwa muhogo na majani yake asubuhi na jioni. Hapa vinaliwa vyakula vinono vilivyoandaliwa kwa ajili yao tu ikiwa ni jaza yao ya kwenda kukubali kukiri kosa na kwenda mahakamani kutoa ushahidi dhidi ya wengine.*

(uk 154)

### **Kunyimwa Huduma za Matibabu**

Gerezani walimo watuhumiwa hamna huduma za matibabu. Wanakandamizwa kama kwamba wao si binadamu wanaostahili kupata huduma bora au huduma zozote za matibabu. Wanapoteswa, yale majereha yanapona kwa hisani ya mwenyezi Mungu kwa vile hawapati huduma zozote za matibabu. Kwa mfano, Sururu anapotiwa katika chumba cha akina Hamza ameumizwa sana, mwili wake umevunda, unakenyakenya na unatoja rojo ya usaha. Mgongoni mmefanya mashata ya damu na usaha juu ya misirimbo ya michapo mikali ya fimbo na viboko iliyomzonga mdawari mgongoni kuzungukia mbavuni mpaka tumboni. Akina Hamza wanamsafisha yale madonda yaliyomjaa mwili mzima, huku akiugua na kusunoneka kwa ukali wa maumivu anayopata. Tunasoma:

*“Chumba kizima walikuwa wauguzi na Abdul ndiye muuguzi mkuu wa kuyatumbua- tumbua yale mashata ya usaha na kumsafisha” (uk 21).*

Kule kwa Ba Mkwe, Hamza na Doto wanaugua na kuuguzana bila ya msaada wa matibabu maalum. Vilevile, Hamza anapougua mle chumba cha kiza, hashughulikiwi kwa vyovyote. Anapomwarifu Koplo Usi, hana haja na ugonjwa wa Hamza. Anapokea matibabu anaporejeshwa kwa Ba Mkwe baada ya kuzidiwa na homa.

Aidha, mmoja wa watuhumiwa anakosa kufika mahakamani kwa kuwa amefariki kwa kuugua tumbo la kuhara. Kwa mujibu wa wafungwa wenzake, Amhasi Ahmed anafariki kwa kukosa matibabu.

### **Kupigwa Kinyama**

Matumizi ya nguvu kwa kuwadhulumu wafungwa yanafikia kilele kwa kipigo cha kinyama. Mateso haya yanaweza kulinganishwa na mateso ya hadharani yaliyotekelezwa kwa wahalifu katika ‘Enzi ya Mateso’ kule Ulaya kabla ya kuanzishwa kwa gereza kama njia ya kuadhibu. Inaonekana hii ndiyo moja ya mbinu kuu za kuwatesa wafungwa zinazotumiwa na wenye mamlaka kwa kuwa ni masimulizi ambayo yameenea pakubwa katika kazi za fasihi ya kifungoni. Ngugi (1991), Kihoro (1998) na Kinyatti. (1996) pia

wamelizungumzia jambo hili.

Kule kwa Ba Mkwewe Hamza na wenzake wanapigwa kinyama ili wakiri kuwa walihusika katika uhaini. Wanatwangwa kwa fimbo za mipera mpaka wengine wanapoteza fahamu na wengine kufariki. Udhalimu huu unatekelezwa na wanajeshi waliokuwa na vyeo vya juu, wenye mamlaka, nguvu na uwezo. Tunasoma:

*“Wale wanajeshi walikuwa ni wa vyeo vya juu waliobeba tepe nzito mabegani. Kila moja wao alikuwa na gongo la mpera mkononi. Magongo yenyewe yamekaa kama mapikipiki ya kupopelea embe” (uk 37-38).*

Taswira ya mateso ya Hamza anayoisawiri mwandishi kule kwa Ba mkwe, ni kielelezo cha namna walivyoteswa washukiwa kwa kutwangwa sana. Tunaambiwa kuwa, askari wa usalama alimtwanga Hamza kwa gongo la mpera kichwani, damu ikamwagika na kutapaka kote; juu ya makaratasi, nyingine chini na nyingine ikachuruzika usoni. Wengine wote wakamwingilia kama nyuki aliyechokozwa. Alipigwa mpaka akashindwa kusimama kwani hawakuchagua pa kupiga. Mle ofisini:

*Alivishwa kitanzi shingoni wakamburura huku na huku na yeye akawafuata kama ng’ombe aliyevisywa shemere. Damu ikimwagika, denda likimchururika. Alipiga kelele kuomba huruma yao mpaka sauti ikapotea ikawa haitoki tena. Lakini huruma itoke wapi nyumba ile. Alibaki kukoroma tu. ( uk 40-41).*

Kuna wengine waliopigwa hadi wakafa na hakuna lolote walilotendewa wale madhalimu. Chumbani anamofungiwa Hamza anaikuta maiti ya Kidau ambaye amepigwa hadi akafa. Maiti inachukuliwa usiku kwa kutiwa ndani ya gunia. Udhalimu wa aina hii ni sawa na ule uliofanyiwa wafungwa wa kisiasa kule Afrika Kusini wakati wa Enzi ya utawala wa ubaguzi wa rangi. Kwa mujibu wa Buntman (2003:18), washukiwa walifungwa bila kuhukumiwa na mle gerezani wakati mwingine waliteswa hadi wakafa.

Kuna mifano mingi riwayani inayoonyesha namna viongozi wanavyotumia nguvu kuwakandamiza washukiwa kwa njia ya kuwatesa. Tulivyosema kwingine, lengo lao ni kuwashurutisha wakiri kuhusika katika uhaini. Wale wanaoshindwa kustahimili mateso haya, wanakiri. Wanakiri sio kwa sababu walihusikalakini kwa kutaka kuponya roho zao.

Kwa mfano, tunamwona Marzuku, mmoja wa washukiwa wale tisa akiwaza na kujuta kwa kubuni kisa, akakiremba na kuwajaza mahaini wote, kila mmoja na jukumu lake. Lakini alitenda lile kwa sababu ya kuteswa. Tunasoma:

*Lakini angefanya nini siku ile waliyomvamia, wakamtwanga, wakamfundafunda, wakamninginiza kwenye kitanzi mavi mabichi yakamtoka, “Ningefanya nini na wao wamenisimamia kama Ziraili wanaitaka roho yangu?” (uk 153).*

## ii. Mateso ya Kisaikolojia

Kisaikolojia, washukiwa wanateswa kwa njia mbalimbali. Wanafungiwa katika mazingira ya upweke hali ambayo inawasababishia kusononeka. Mfano wa Hamza anayefungiwa katika chumba cha kiza na Haramia anayefungiwa chumba kimoja na Chatu. Kufungiwa gerezani pia kunawatenga na familia zao kule nje. Sheria za nchi hii ni kama haziruhusu wafungwa kutembelewa na jamaa zao au kama zinaruhusu, basi sheria hiyo haitekelezwi.

Katika *Haini* tunawaona wafungwa wakiwaza na kusononeka sana kwa sababu ya mawazo ya familia zao kule nje. Nassor na Hamza ni mifano wa wafungwa ambao tunakumbana nao wakiwa ndani ya mawazo mengi wakati mwingi. Kule Kumbakumba Nassor anamlilia mkewe na watoto wake hadi wakampa jina la “*Big Baby*”. Hamza naye wakati mwingine, tunamwona akimuwaza Khadija na mtoto wake. Tunasoma:

*Mawazo yale yalimjaa kichwani mpaka kichwani humo mkawa hamna nafasi ya kuwaza jengine lolote zaidi ya Khadija, mke wake mpenzi. Ametenganishwa naye kwa kuwekewa senyenge, akaekewa na askari wa kumlinda na bunduki mkononi, na walinzi wengi waliokaa makini. (uk70).*

Kinyatti (1996) na Sithole (1976) wana tajriba kama hizi katika maisha yao gerezani. Katika jamii zao, kutembelewa gerezani ni jambo lililowekewa vikwazo vingi, na iwapo mtu alitembelewa mgeni alipewa dakika chache za kuonana naye kupitia kwa waya au

kioo. Hali hii ya wafungwa kutenganishwa na familia zao inawazulia mahangaiko na mateso ya kiakili.

### **Adhabu za Kigereza Katika Jamii Pana**

Kwa mujibu wa nadharia ya Ki-Foucault, mfumo wa kuadhibu wa Kigereza umeenea katika jamii nzima kwa kile anachokiita ‘Bahari ya Kigereza’ au ‘Mji wa Kigereza’. Foucault anasema hivi kwa kuwa mfumo wa kisasa wa kuadhibu, unadhibiti maisha ya kila mtu lifanyavyo gereza. Gereza limesawiriwa kuwa sitiari ya jamii zetu na kwa kutumia taswira hii, mwandishi wa *Haini* anadokeza mfanano uliopo baina ya gereza na maisha yaliyo nje ya gereza.

Mbali na kuwa matukio mengi ya riwaya hii yamejengwa katika mazingira na tajriba za gerezani, mwandishi ameyamulika maisha yaliyo nje ya gereza na kuonyesha namna yalivyo na mfanano na yale ya gerezani kwa kiwango fulani. Dhuluma sio tu zinawakumba wafungwa gerezani, bali pia watu huru kule nje ya gereza. Kwa kiwango kikubwa mwandishi ametumia mateso ya familia ya Hamza kule nje, kuwa kielelezo cha familia za mahaini.

Ukosefu wa chakula si taabu inayolikumba gereza pekee, bali sifa ya jamii nzima. Tunapoitazama familia ya Hamza kule nje, tunaona wanavyoishi kwa taabu ya kuvipata vyakula; kupata bidhaa kama vile mkate na mchele ni tatizo kubwa. Tumeonyeshwa Khadija akihangaika anapotaka mkate. Khadija anasema kuwa, ukienda kwenye duka la ukoo kama siku yako haikufika, hata ukilia machozi ya damu mchele haupati. Mkate kupatikana ni vigumu. Watu hupanga foleni ya mkate tokea usiku na hukesha hapo kusubiri mkate wa asubuhi. Hata hivyo, mkate huo wenyewe hupatikana kwa bahati nasibu tu. Katika duka la Awidhi hakupatikani bidhaa. Mzee Maftah anapotafuta kiambatanishi cha kunywea chai, hapati chochote huko.

Kuna ukosefu wa chakula katika nchi nzima. Masanja anakamatwa kwa sababu ya kununua unga wa Magendo kule Kombeni. Abdul naye akiwa gerezani, anaeleza kuwa nchini kuna ukosefu wa sukari na mchele lakini ukiongea unatiwa ndani.

Khadija vilevile anakabiliwa na dhuluma za kila aina kule nje. Tumeambiwa kwamba amefukuzwa nyumbani kwake kwa kushindwa kuilipia nyumba, tukio linalomfanya kuhamia Kisimamajongoo kwa wazazi wake. Azizi, mmoja wa maafisa wakuu serikalini anatomia fursa ya hali inayomkumba Khadija kumkandamiza kimapenzi. Kwa ujumla, wake wa mahaini wanaonwa kama mahaini na wamekuwa watu wa kutorokwa, kwa hivyo wanakaa kwa pweke walivyo wafungwa gerezani. Kwa mfano Baraka, na mkewe wanamtoroka Khadija kwa kutotaka kuhusishwa na mahaini.

Kisaikolojia, jamaa wa familia za Mahaini wamekolezwa mateso kwa kutenganishwa na jamaa wao. Familia nyingi zimesambaratika kwa kuwa watu wengi wamekamatwa na kufungiwa gerezani. Tunaona vile Khadija anaumia kimawazo kwa fikra za mumewe ambaye haijui hali yake wala hatima yake. Ni dhahiri Khadija ameumia kiasi kwamba, amethubutu kutafuta njia za kumwokoa Hamza kutoka katika janga lilomfika; anajaribu kwa Baraka – anamtoroka, anafikiria Azizi atamponya – anakuwa mnafikiki mkubwa, naye mganga, Kidongo Chekundu, hakumfaa. Hatima yake ni mawazo, mchana kutwa na usiku kucha kumhusu Hamza.

*Naye mkewe Khalfani, maisha yamemwia magumu kule nje. Mwanamke huyu amekata tamaa na kudai talaka kwa Shekhe, sasa ameolewa na mume mwingine. Khalfani mle gerezani amepata ujumbe huu, anaumia ndani kwa ndani. Kila siku anakonda.*

Hali ya maisha ya familia za wafungwa, kama inavyosawiriwa katika kazi nyingi za fasihi ya kifungoni, zinaishi maisha ya Kigereza wanavyoishi jamaa wao walio gerezani. Katika ujumbe wake kwa Maina wa Kinyatti akiwa gerezani, Jeff Mwangi anamwambia: “Kumbuka sio wewe pekee uliye gerezani, sisi sote tumo gerezani kwa kuwa tunaishi katika taifa linalotawaliwa na askari” Naye Mumbi, mkewe, anamwambia, “...mambo si mazuri huku nje. Ukatili umezidishwa. Watu wengi sana wamekamatwa, wengine wanateswa kule Nyayo House na wengine wengi wamepotea” (Kinyatti, 1996:186). Nukuu hizi ni mfano wa kuthibitisha namna jamii zetu zilivyo za kigereza kimwelekeo.

Jambo analolitia mkazo Foucault kuhusu muundo huu wa Kigereza, ni namna ulivyoathiri jamii pana. Gereza limesawiriwa kuwa sitiari ya jamii pana. Mnara huu wa uchungulizi ni sitiari ya serikali ambayo ina uwezo wa kuyachungulia maisha ya raia. Viongozi wanatumia mbinu mbalimbali katika kuchungulia mienendo ya raia. Wale raia walio na mawazo yanayokinzana na ya viongozi, hukamatwa na kutiwa gerezani. Moja katika mbinu za uchungulizi zinazotumiwa katika *Haini* ni ujasusi. Viongozi wana watu maalum wanaodadisi na kufahamu kinachosemwa na watu. Kwa mfano, Zonga amewekwa gerezani miongoni mwa mahaini ili awachunguze.

Kuna mifano zaidi ya wahusika wanaotumiwa na viongozi wakuu Serikalini kudadisi wanavyosema watu. Haramia ni mmoja wao, kabla ya mauaji ya Kigogo. Anavyosema mwandishi, Haramia alikuwa ni mmoja wa vitimbakwiri vya Kanali Bunju alivyovisambaza kila pembe vikinusa na kuduhushi mambo na kumpelekea habari. Naye Faraji ameajiriwa na Kapera, afisa mkubwa katika Idara ya Usalama. Kazi yake ni kumtafutia habari. Nani anasema nini, huyu anafanya nini, yule anaongea nini.

Baada ya Kifo cha Kigogo, hali hii imeendelezwa zaidi. Hali ambayo imesababisha hofu miongoni mwa wananchi. Watu wanazungumza kwa minong'ono kwa kuwa, hakuna anayemwamini mwenzake. Tunamwona Bi. Farashuu akimwonya Khadija azungumze kwa sauti ya chini asije akasikika likawazukia balaa anaposema kuwa siku hizi kila pahali pana foleni, anapotaka kwenda kununua mkate.

Katika hali, hii mwandishi anaeleza kwamba mji umepwaya kimya, utadhani umeelemewa na jinamizi, nyoyo za watu zimejaa hofu na wasiwasi. Hakuna anayejua lini au saa ngapi atatiwa mbaroni, watu wanakwenda na kurudi kila mmoja akiwaza labda sasa hivi au halafu. Mwandishi ameendelea kueleza kwamba, waliokuwa wakizungumza, wakinong'ona, kwa kuwa roho za watu zimekosa imani na hakuna anayemwamini mwenzake. Kila mmoja anamwona mwenzake kuwa jasusi.

Kwa mujibu wa Foucault, lengo kuu la matumizi ya mfumo wa Kigereza katika jamii pana, ni kuudhibiti umma kwa kuzalisha jamii tiifu. Hili ndilo tunaloliona katika *Haini* ambapo tunaiona jamii iliyodhibitiwa kabisa na serikali; watu wanaishi kwa hofu kuu na

kutenda mambo kulingana na matakwa ya serikali bila kulalamika kwa njia yoyote ingawa wanateseka sana. Kwa Foucault, hiki ndicho kilele cha kuudhibiti umma kwa kuwa watu sasa, wanajilinda wenyewe kwa hofu kwamba matendo yao yataonekana hata kama wayatendayo hayaonekani.

### **Hitimisho**

Tumeonyesha jinsi mwandishi Adam Shafi ametumia taswira ya gereza kuendeleza maudhui katika riwaya yake ya *Haini*. Imebainika kwamba, asasi ya gereza haitumiwi katika kuwarekebisha watu tabia, bali inatumiwa kama chombo cha kuunda jamii ya wahalifu na kwa njia hiyo, kuidhibiti jamii hii kwa kuitesa na kuidhalilisha. Ni asasi inayotumiwa na wachache wenye mamlaka kutekeleza matakwa yao. Athari za gereza hazionekani tu katika gereza, bali pia zinavuka mipaka na kuwaathiri walio nje ya kuta za gereza. Mwandishi ameonyesha ufanano uliopo kati ya gereza na maisha yaliyo nje ya gereza. Sura hii vilevile imeonyesha namna masuala ya adhabu na nguvu yanavyosawiriwa na kuendelezwa katika *Haini*.

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**An investigation of English writing errors encountered by Certificate in Law students in Tanzanian institutions: The case of Institute of Judicial Administration Lushoto**

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**ABSTRACT**

This study aims at exploring the English academic writing errors that encountered by a certificate in Law students in Tanzania. These problems arise because the students are not adequately familiar with the English language and they do not have enough practice of it. This article highlights the main reasons behind the problems of writing and recommends some solutions to overcome them. The skill of writing is not only important but also an important productive skill hence it must be taken into consideration in any learning and teaching programme. The study employed structural accuracy and communicative potential (Dar & Khan, 2015 as its theoretical framework. Data for the study was collected via questionnaire and interviews from four selected institutions offering Certificate in Law programme in Tanzania. The findings of the study reveals that students face problems in relation to content, organization of ideas, and language use. Finally, the study recommends to those institutions on the appropriate remedies that can be undertaken as the certificate students are seen as potentials for further learning stages in a law carrier.

**Keyword:** writing problem, errors, L1, L2, certificate in law

**1.0 INTRODUCTION**

The study of English writing errors have been done in various perspectives of education, however, some of the areas have been left out. One of them is in the institution of higher learning. Thus the study is aimed to investigate English writing error mainly found to certificate in law students in. The general objective of the study is to analyse writing error analysis of certificate in law students in two higher learning students in Tanzania. The specific objectives of the study are: To identify the writing errors made by certificate in law students in their learning English and to classify the errors which cause writing in English? The present study will seek to answer the following questions: What is the most

common language errors made in English writing by the certificate in law students in Tanzania? What are the possible causes of the errors in writing English made by the certificate in law students?

It is expected that the findings of this study would provide a basis for assisting English language lecturers to adopt teaching methods that will enhance the learning of writing skills among college students. Secondly, the study would facilitate curriculum developers and textbook writers to come up with materials that will address the challenges college students face in L2 writing. Finally, the study can also contribute to the knowledge of classroom research in second language writing and form a basis for further research which could prompt other researchers to do similar studies in other higher learning institutions offering certificate in law programme.

Writing is the language skill that should be constantly improved from time to time. It means that this skill involves clear thinking about what to write. Students should be taught how to express their ideas in written form without regular practice. Writing can be boring and frustrating to students who learn English as the target language because they do not enjoy or they have no ideas to develop when they write. Principally, the main function of writing is an indirect device of communication. By writing, the students will be able to explain their thoughts or their purposes.

Nevertheless, writing is one of the most challenging language skills in second language learning. In fact, even for those who speak English as a first language, the ability to write requires long, intensive and specialized instruction. When the students write their feelings and ideas into a word, word into a sentence, sentence into a paragraph and it needs hard thinking to produce the good writing at the same time. As Gyula Tanko (2000:26), "Writing is a complex activity that requires much more than good language knowledge". It means that to put down the ideas in words one must have the knowledge and the time to develop his or her skill in writing.

On the other hand, errors are breaking the rule, due to a lack of competence such as knowledge of the language, which may or may not be conscious, Corder (1973:257). It means that insufficient competence in a language cause someone to make an error. The errors can occur either consciously or unconsciously when the learners write down

something.

Before we push our discussion further, let us clarify key concepts used in this study. Error, An error is the failure to use the grammatical system correctly made by the students which are caused by the lack of student's competence. Mistake, The mistake is referred to a performance error that is either accidental or a slip of the tongue, in that it is a failure to utilize a known system correctly (Brown, 1980: 165). Error analysis the error analysis is the study of students' error which can be observed, analyzed, and classified to reveal something of the system operating within the learners. Writing is an activity to express ideas, feelings, opinion and information in printed symbols. Competence The ability that students need to develop in order to express themselves appropriately and effectively in various situations. Performance Refers to the ability or level of competence of a student in writing, measured by means of an achievement test. Second language is acquisition and learning of an additional language after the first language (L1).

Writing is the most challenging area of learning the second language. It is based on the appropriate and strategic use of language with structural accuracy and communicative potential (Dar & Khan, 2015; Hyland, 2003; Mahboob, 2014). Kellogg (2001) opinions that writing is a cognitive process that tests memory, thinking ability and verbal command to successfully express the ideas; because proficient composition of a text indicates successful learning of a second language (Geiser & Studley, 2002; Hyland, 2003; McCutchen, 1984; Nickerson, Perkins, & Smith, 2014). Therefore, learning how to write has gained considerable importance for the last two decades due to two factors: its use as a tool for effective communication of ideas and the extensive research work carried out in this area to examine various issues faced by L2 writers (Dar & Khan, 2015; Graham & Perin, 2007; Haider, 2012; Hyland, 2003; Muhammad, 2016).

According to Norrish (1983:7), the error is a systematic deviation from the accepted system of the target language. Then Brown (1980:165) states that an error is noticeable from adult grammar of a native speaker, reflecting the interlanguage competence of the learner. Mistakes are imperfectness of utterances which refer to the language performance. It is clear that error and mistakes are different. A mistake is a deviation due to performance factor, like the limitation of memory. It can be corrected by the learners

themselves where their attention is drawn towards their errors while an error is a deviation due to language competence.

Therefore, it can be urged that an error is a systematic deviation; when a learner has not learnt something and consistently gets it wrong (James, 1998: 77, cited in Bahri & Sugeng, 2008: 3). Also, an error is a systematic deviation from the norms of the language being learned (Corder in Gass & Selinker, 2001: 78). Errors in various forms are important sources of information about foreign language acquisition, because they demonstrate conclusively that learners do not simply memorize the target language rules and then reproduce them in their utterances. They indicate that learners construct their own rules on the basis of input data, and that in some instances at least, these rules differ from those of the target language learners (Ellis, 1985: 9).

According to briefly reviews above it is observed that many scholars explain how writing error analysis is important and how this writing error can be detected easily in written work. Even though many scholars have done a lot of research on writing error analysis of English in many countries around the world but they did not attempt to do a research on writing error analysis in the Tanzanian context especially in the certificate in law programme at the institutions that offers the certificate programme. So the researcher used their ideas as a foundation to find out how writing error analysis is important and how they can be eliminated easily in written English works of certificate in law students in Tanzanian context.

### **Theoretical framework**

The study was guided by marking an error is a motivation of learning L2 principle. According to Ellis (1995:51-54), the most significant contribution of error analysis lies in its success in elevating the status of errors from undesirability to that of a guide. Hence, errors are no longer seen as ‘unwanted forms’ but as evidence of the learners active contribution to foreign language acquisition. Therefore making errors should not be treated as negative persuasion in language acquisition. Norrish (1983:21-42, cited in Sattayatham & Ratanapinyowong, 2008: 23) described the causes of language learner’s

errors as arising from carelessness, interference from the learner's first language, translation from the first language, contrastive analysis, general order of difficulty, overgeneralization, incomplete application of rules, material-induced errors and a part of language creativity.

## **2.0 METHODOLOGY**

The qualitative approach was used to collect and analyze data as with an aid of the descriptive design. The researcher worked more at identifying and describing the learner's errors made in their written works/compositions. The approach was vital to the study for the researcher had full managerial power over the respondents in collection and analysis of data. The research was conducted at the Institute of Judicial administration Lushoto, Tanzania. The choice of the institute was due to two reasons, firstly, it's one of the institution that teaches certificate in law programme that is accessible by the researcher and second is due the previous reason, the researcher thought that the errors made by the rest of the learners in the study area in the district are some way of the same nature. Data was collected from a total of 240 certificate in law students who registered for communication skills course. The sample size was appropriate for the study because the errors learners make seem to be same or relating, so thereafter data collection and analysis will be generalized to mass of the learners in the study area in the district.

### **Data collection instruments**

Data was collected through the provision of written-duties to the learners. This was in form of open compositions which was administered by the researcher to certificate in law students with the permission of the head of department of Judicial and legal studies. The undertaking took two hours to accomplish. The management of the research instrument by the researcher was done in a way that there was no any kind of anxiety or fear to the learners. The choice of open compositions on the other hand, gave the learners an opportunity to express themselves freely without restrictions.

## **3.0 RESULTS AND DISCUSSIONS**

Findings achieved by this study are actually showing that learners commit some linguistic errors when writing their compositions and essays. The researcher detected seventeen

(17) categories of errors as committed by college students. Therefore, the presentation of findings has been done following categories of the data detected where as the sentences in italics are right construction of the wrong sentences on top them done by the learners in their writings; consider the data categories here on:

### **Errors on Clipping of Auxiliary verbs**

The researcher found this category of errors on the students' compositions in which half of the total sample of research population tends to leave out the auxiliary verbs different from the normal construction of correct grammatical sentences made on their compositions resulting vague meaning. This case happens in grounds like instead of writing "*I am cooking Ugali*", most learners write \*"*I cooking Ugali*" which for them is regarded as good construction because of their linguistic incompetence.

Example (1):

- a) \*I running quickly

*(I was running quickly)*

- b) \*She my friend

*(She is my friend)*

- c) \*They students of mukulu secondary

*(They are students of Mukulu secondary)*

- d) \*My parents sleeping when a thief came.

*(My parents were sleeping when a thief came)*

- e) \*I born in 1995

*(I was born in 1995)*

- f) \*He shocked to see us without information

*(He was shocked to see us without information)*

### **Errors on double ungrammatical use of Auxiliary verbs**

Most students lack clear knowledge on how to use the helping verbs to the extent double unconnected helping verbs are used at the same time in the same sentence something which is not accepted in English language. The improper construction like \* "*I am is a student*" is out of normal grammatical construction which was done by over fifty percent (50%) of the research sample size which its right construction should be "*I am a student*". Observe some more same cases in data 2.

Example (2):

- a) \*The members have was a family  
(*The members were a family*)
- b) \*My friends is do an exercise  
(*My friends are doing an exercise*)
- c) \*People were are in the house  
(*People were in the house*)

### **Errors on wrong tenses use**

Tenses are very important in using any tensed language effectively. Unless one masters them, he will use it very poorly in a sense that the construction may be ungrammatical and lack clear meaning as a result communication cannot be effective. Third-quarter of the research sample size have been noted committing the errors in wrong tenses use like \****“I writing notes yesterday”*** which supposed to be ***“I was writing notes yesterday”***. This kind of construction is due to inadequate grammar rules and principles.

Example (3):

- a) \*One day there are some people  
(*One day there were some people*)
- b) \*John was travel to Mwanza  
(*John was traveling to Mwanza*)
- c) \*We decided to went to school  
(*We decided to go to school*)
- d) \*Yesterday I kill a very big snake  
(*Yesterday I killed a very big snake*)
- e) \*I come here tomorrow  
(*I will come here tomorrow*)
- f) \*We written the letter  
(*We wrote the letter*)

### **Subject-verb agreement Errors**

Forty two percent (42%) of learners' writings there are errors on mismatch between the subject of the sentence and its verb. One of the rules in English grammar is subject-verb

agreement which a subject and a verb of a sentence must be agreed. This can be exemplified in a sentence like \* **“My shoes is black colored”** which it’s correct construction would be **“My shoes are black colored”**. The down- listed are some findings from student’s writings:

Example (4):

- a) \*All is my shoes  
*(All are my shoes)*
- b) \*The people is running  
*(The people are running)*
- c) \*My books is in the bag  
*(My books are in the bag)*
- d) \*My mother are a teacher  
*(My mother is a teacher)*
- e) \*Martin are teaching English subject  
*(Martin is teaching English subject)*
- f) \*She have small eyes  
*(She has small eyes)*

#### **Errors on disagreement between Determiners and nouns**

Disagreement of demonstrative pronouns and their nouns is a big challenge to quarter of a total sample of secondary school learners through which the sentences in their compositions tend to be vague for lack good meaning. For instance the construction *like* \***“Many parent are farmers”** there is no match between **“Many”** and singular noun **“parent”**. Observe some more data here down:

Example (5):

- a) \*This people is lived  
*(These people lived)*
- b) \*Those animal is a lion  
*(Those animals are lions)*
- c) \*All book were in the classroom.  
*(All books were in classroom)*
- d) \*I saw some student walking out

*(I saw some students walking out)*

- e) \*Many orange are in the basket

*(Many orange are in the basket)*

### **Errors on words-spelling**

The researcher found that third-quarter of sample size committed errors on spelling of words during the write up of the compositions by the secondary English learners. The errors which if a marker of their compositions is not connected the students' first language cannot understand the meaning of the sentences with errors. For instance some learners in their compositions wrote \***"their"** instead of writing **"there"**.

Example (6):

<b>Wrong</b>		<b>Right</b>
a)	*There	their
b)	*Maney	money
c)	*Fall	Fail
d)	*Belive	believe
e)	*Farther	father
f)	*Claying	Crying
g)	*Parrents	Parents
h)	*Befor	Before

### **Errors on wrong use of relative pronouns**

There is mismatch between the relative pronouns and their nouns there refer to. Half of the sample learners do not know the proper use of the relative pronouns. The task which a researcher gave the learners to write was attempted with lot of these errors. For instance instead of writing **"who"** to make relationship to personal subject like **"students who were in the class"**, they used the non-living and animals pronouns **"which"** like **\*"students which were in the class"**. More findings are down-listed:

Example (7):

- a) \*People which I saw

*(People whom I saw)*

- b) \*The friends which came here

*(The students who came here)*

- c) \*The house whose was black

*(The house which was black)*

- d) \*My pen who I lost last week

*(My pen which I lost last week)*

### **Errors on the use of a noun and its pronoun**

These errors have been seriously done by third-quarter of the sample learners on their compositions where by noun and its pronoun is used at a same time repeatedly. This is not accepted in English rules and principles of sentence construction, for instance some wrote \**“people they saw me”* instead of writing *“People saw me”*. This is done unconsciously because third-quarter of the sample population was seen lack sufficient knowledge on the grammar rules and principles. The findings here down verify the scenario:

Example (8):

- a) \*An old man he take

*(An old man took)*

- b) \*People they went out

*(People went out)*

- c) \*Jenifer she told a teacher

*(Jenifer told a teacher)*

- d) \*Our cow it is very big

*(Our cow is very big)*

- e) \*My friend he is Moses

*(My friend is Moses)*

- f) \*Education it is very important

*(Education is very important)*

### **Errors on misuse of preposition “for”**

Prepositions have been a huge problem to secondary English learners both in speaking and writing the English language. The researcher has come across with misuse of the preposition *“for”* in quarter of learners’ compositions on how to express an instrument

where the learners do not know how to use preposition “by” when expressing an instrument which performed an action in sentences. Taking an example instead of writing “*She killed a snake by a knife*”, quarter of the sample does not know this and wrote \**“She killed for a knife”*

Example (9):

- a) \*She killed a snake for a knife  
(She killed a snake by a knife)
- b) \*They travelled for a bus  
(They travelled by a bus)
- c) \*He was hit for a stick  
(He was hit by a stick)

### **Lack of Gender Agreement**

Third-quarter of Learners failed to mark gender appropriately in their writings. Pronouns are irregularly used where the masculine pronouns are used to feminine nouns like in \**“my mother he is a teacher”* and feminine nouns are used to masculine nouns like in \**“John she is my best friend”*. The italicized words in the following constructions are incorrectly used.

Example (10):

- a) \*My sister *he* wrote me a friendly letter.  
(*My mother wrote me a friendly letter*)
- b) \*Joyce lost *his* car.  
(*Joyce lost his car.*)
- c) \*My father told *her* friend to come home.  
(*My father told his friend to come home.*)
- d) \*The girl he has good manners  
(*The girl has good manners*)
- e) \*She he has shoes  
(*She has shoes*)

### **Error on wrong use of Subject “me”**

Use of ‘*me*’ as a subject was also common to half of the sample learners whereby they came up with constructions such as \**“Me I asked her a question”*. One of the rules

in English language is that Objective pronouns “*me/them/her/him*” cannot begin a sentence. The italicized word is incorrectly used.

Example (11):

a) \*Me I asked her to come

(*I asked her to come*)

b) \*Him he ate mangoes

(*He ate mangoes*)

c) \*Me I went out

(*I went out*)

### **Errors influence by mother tongue**

Mother tongue (first language) also has been seen having impact on the English language learners’ writings, quarter of learners wrote as the way they pronounce their ethnic language or Kiswahili as in “*Input*” they wrongly wrote \**“Imbut”*. Third-quarter of other learners inserted new vowels to separate consonant clusters which seem difficult to pronounce like in “*Dislike*” they wrongly wrote \**“Disilike”*. Observe some more findings in the two scenarios as listed here down:

Example (12):

a) \*Enducantion (Education)

b) \*Angricunture (Agriculture)

c) \*Environiment (environment)

d) \*Abonshen (abortion)

e) \*Yu gai (you guy) Influence from Sambia lexemes and pronunciation

f) \*Disilike (dislike) Vowel insertion

g) \*Moslem (Muslim)

h) \*Ischool (School)

i) \*Studiying (Studying) Vowel insertion)

## Errors on Punctuations

Learners have been discovered are not aware of the punctuations and how correctly to use them when writing compositions. Half of the sample population does not observe the punctuation markers in their written compositions and lot of errors were found in their texts for instance quarter of the sample began a sentence with a small letter like \**“my friends students were in the class room”* something is not correct in English language and should correctly be *“My friends students were in class room”*. The listed are errors which were detected in the learners’ writings:

Example (13):

- a) Third-quarter of learners did not put period/full stop at the end of the sentence.
- b) Half of the research sample started a sentence with a small letter.
- c) Quarter of the sample learners used capital words irregularly in between other words in a sentence.
- d) Quarter of the learners mix the capital letters and small letters together.
- e) Half of the sample learners also replace comma for a full stop.
- f) Third-quarter of learners used commas irregularly in a text without any linguistic necessity.

## Errors as a result of lack of confidence

It has been discovered in this research that third-quarter of sample learners have insufficient and also not sure of the words they use to write in compositions, where by third-quarter of sample learners wrote a correct word and then cancelled it and replaced another one which was not correct. Learners shared answers and copy written compositions from those who they believe wrote excellently. This is evidently seen in cancelling *“dormitory”* the right word and writing \**“domitory”* the wrong word. See some more findings here down:

Example (14):

	Right	Wrong
a)	<del>Dormitory</del>	*domitory
b)	<del>Environment</del>	* Enviroment

c) features

\*features

### Errors on possession construction

Half of sample learners have inadequate knowledge on how to make good sentences which express possession or belonging. Instead of using possessive makers used complements to express possessions knowing that they are right to do so. For instance instead of writing “*she has big eyes*”, the third-quarter of sample learners wrote \* “*she is big eyes*” something which is not accepted in English language.

Example (15):

a) \*She is big eyes

*(She has big eyes)*

b) \*Saphina is a good behavior

*(Saphina has a good behavior)*

c) \*She is big head

*(She has a big head)*

d) \*Saphina is strong finger

*(Saphina has a strong finger)*

e) \*She is two eyes

*(She has two eyes)*

### Errors on word classes disordering

It has been revealed through this study that half of the sample learners have no mastery of good use of parts of speech in a sentence level. The word classes have rules and principles on their use which are linguistically accepted, and one of the rules rely on the ordering of the parts of speech. Learners made disordering of parts of speech in their compositions written. Observe the following case \* “*The girl has nose large*” this was wrongly written by half of the sample size who suppose to correctly write “*The girl has large nose*”. See more data here down:

Example (16):

a) \*The girl has nose large

*(The girl has large nose)*

- b) \*She has teeth white  
(*She has white teeth*)
- c) \*I was write notes English  
(*I was writing English notes*)
- d) \*Me and Joyce was in the class  
(*Joyce and I were in the class-room.*)

### **Errors on improper use of pronoun “It”**

Quarter of sample learners’ writings have been observed that they do not know the proper use of pronoun “It” for it is wrongly used to mark any human gender thinking that they are right to do so. A learner was confidently writing “it” meaning he or she in a sentence for instance in \**“Mwajuma it white in color”* instead of writing *“Mwajuma is white in color”*. Some more findings are hereafter:

Example (17):

- a) \*Mwajuma it white in color  
(*Mwajuma is white in color*)
- b) \*It is a member of Islamic religion  
(*She is a member of Islamic religion*)
- c) \*It is smart girl  
(*She is smart girl*)
- d) \*It have two eyes  
(*She has two eyes*)

Having identified the errors certificate in law students’ perform in examples (1-17), let us now summarize the general causes of the errors in the following subsection.

**Interlingual Causes of Errors,** Interlingual causes of error are also known as mother tongue (MT) or external interference. Mother tongue interference is defined as the use of elements from one’s native language while learning a second one.

Mother tongue interference is the main problem in learning English as a Foreign Language (EFL) and learning English as a Second Language (ESL). Many of the students make mistakes in writing due to the mother tongue interference.

**Non-use of the subject-verb agreement,** Learners tend to produce the sentence like “John kick the ball”. This is because the there subject-verb agreement in Kiswahili language. Therefore, errors may occur in the subject-verb agreement when they construct sentences in English.

### **Capitalization and Punctuation Errors**

Errors with capitalization and punctuation in writing are also found in Kiswahili learners of English. It is because the use of capitalization and punctuation in English is different from Kiswahili written language.

As mentioned above, the interlingual errors are caused because of the interference of learner’s native language. Likewise, learners commit the errors due to the faulty of partial learning of the second language.

**Overgeneralization,** After acquiring and learning the language to some extent, learner’s process new language data in his or her mind and produces deviant structures and on the basis of his experience and evidence. However, when the learner has limited exposure and the data are inadequate, he or she tends to overgeneralize the rules and creates deviant structures. Therefore, overgeneralization can be seen as one of the causes of error.

Regularizing the language and ignoring exception in order to reduce the learning load or simplify the language are also the main reasons for overgeneralization and wrong analogy. For example, wrong collocation, the omission of “-s” in the third person singular, putting past tense marker “-ed” in irregular verbs.

Moreover, overgeneralization is associated with redundancy reduction. It may occur with items which are contrasted in the grammar of the language which have similar structures or similar meaning, but which do not carry significant and obvious contrast for the learner. Thus, similar forms and structures will be wrongly associated. For example, the learners might replace “too” with “very” in the usage of “too...to” as “I am very tired to study.”

**Incomplete applications of rules,** Incomplete application of rules involves learners failing to learn more complex types of the structure since they think they can succeed effective communication by using relatively simple rules. It arises when the learners do not fully develop a certain structure required to produce acceptable sentences. An example of the incomplete application of rules can be seen in the question forms. Often, questions are used by means of eliciting sentences instead of finding out something transform exercise.

**Ignorance of rule restrictions,** “It is a type of generalization or transfer.” It is making use of rules that the learners acquired before in new contexts where they do not apply. It is because they do not aware of the rules and restrictions of a particular structure. Some of the rule restriction errors may cause because of wrong analogy and memorize of rules. As an example, learners misuse prepositions when they encounter these prepositions with each type of verb because of their wrong analogy to use the same preposition with similar verbs. For example, “we talk about it leads” to “we discuss it”, “he tells him to do it” to “he makes him do it” and so on.

### **Implication of learners’ competence in a job market after school**

Since the results show learners’ incompetence in language use as observed on their compositions, it gives a great worry on how they will perform certain written tasks in various leadership positions after school. Some will work as secretaries, security guards, research assistants, village chairperson and village executive officers and some more other positions; so a question to ask is if while in college fail to write as appropriately as required what if after school? This is impacted from the way learners learn English language as the ability to learn a language is affected by many factors, the main are: cognitive ability of the learner to learn and understand the language and keep it in memory; personality of learners, just to mention but few.

### **3.0 CONCLUSION**

Linguistic errors to most learners’ compositions and other writings are widespread phenomenon. The study has pointed out some linguistic errors which have been committed by the learners in the study area in their writings which area likely done by

most learners in institutions. The errors as have been analyzed categorically depending on the nature of their occurrence each group has its error causative which the researcher has tried to scrutinize and identified some of the causatives. Most errors are due to students' incompetence to the language which also has its gearing factors;

Learners with the errors don't put much effort to master the English language in both speaking and writing. Knowing the language needs practices and huge efforts to find out how it is used in variety of contexts something which most learners don't work upon. This is together with being exposed to variety of written and spoken texts so as a learner understands the good way how to use the language.

Many researches show that a child masters a language through acquisition by an oral means and then learn how to write down by written means. Reflecting that fact, Secondary school learners have no tendency to speak English as communicative language when they are at school and even when off school hours. The researcher thinks that if the learners practice spoken English will enable them to their writings and will to some extent reduce errors in writing.

It has been known through this study that some learners errors committed are due to direct shift of word pronunciation to writings. Some learners wrote the words as the same way they are pronounced i.e /come/- "kam" thinking that they are right to do so without knowing it is the violation of linguistic rules.

Teachers' linguistic incompetence and frequently use of Kiswahili in class-rooms is a great causative to learners' errors in their writings. It has been known through this research that some teachers who teach subjects which its learning-teaching language is English just use the language to read some materials written on the text books then much of explanations are in Kiswahili. This really don't prepare learners to master the language because it is believed that teacher's personality shapes a learner, therefore in learning a language students acquire and copy the words, structure and style of language from the

teacher. So, if much of explanations are done in Kiswahili, learners will be overwhelmed by many errors during their write-ups.

English is the third language to most of learners in the Tanzania though it is a second language to some few in urban areas. The influence of mother tongue and Kiswahili to the learners in the study area is a great source of learners' linguistic errors either on spelling, lexeme or structural level. Some errors as analyzed in this research are due to interaction between the English and first (mother tongue) and second language (Kiswahili).

The study has identified that the English communication skill Syllabus for certificate in law programme does not put much emphasis on the language grammar, rules and principles of the English language. Living in a new village before knowing the norms and culture the place is a big danger, therefore, the same is in languages one should know the rules and principle to apply in the language use before teaching its use in varieties of contexts. The syllabus is more of languages use than language structure something which learners are taught how to use language without knowing the scientific formation of the language structures.

#### **4.0 RECOMMENDATIONS**

Error analysis is the process of determining the incidence, nature, causes, and consequence of unsuccessful language (James, 1998:1). It means by determining students' errors the teacher can not only detect the students' difficulties in learning English but can also determine the effectiveness of the certain method in teaching the language. Brown (1980: 166) says that error analysis is the study of students' error which can be observed, analyzed, and classified to reveal something of the system operating within the learners. Brown's point of view implies that error analysis is useful for the teacher. Error analysis will show teachers some problems confronting the students. It is an advantage that error analysis may be tracked down to the importance of students' errors.

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**Assessment and relevance of English communication Skills syllabus to Diploma in Law programme in Tanzania: Does it bring Competency Based education and training as expected?**

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**ABSTRACT**

Appropriate and well-designed Curriculum is one of the variables that may contribute to sustainable development in any given society. The syllabus can reflect the type of end product of graduates that any education system ought to produce. This paper assesses the Communication skills curriculum in the institutions offering diploma in law programme in Tanzania. Looking on English communication skills curriculum, one may raise a concern whether that the current syllabus will create diploma graduates who are well equipped with competence based education and training, instead of knowledge based, thus contributing to sustainable development. The content of English communication skills for these institutions not only not harmonized but also does not reflect on English communication skills for lawyers, instead one finds loaded with English grammar as if the programme is intended to humanities programme, thus reflecting knowledge based education. The paper suggest the need for harmonizing the English communication skills for diploma in law programme and conducting several workshop organised by the appropriate organs such as National council for technical education on the methodology of implementing the competency based teaching. The paper concludes that unless the knowledge based education and training contents are changed, the expectations of producing graduates with competence based education and training is far from reality.

Keyword: Competency based, knowledge based, education, communication skills, syllabus

**1.0 INTRODUCTION**

This study is intended to assess the relevance of English communication skills syllabus to Diploma in Law programme in Tanzania. Specifically, the study is intended to analyse the

English communication skills syllabus to Diploma in Law programme in Tanzania and evaluate the reflection of the curriculum in attaining the required competencies to a diploma in law graduates. The findings of this study will therefore be used to revisit and reshape English communication skills for diploma in law programme in order to come with competence based curriculum, thus to facilitate competencies in the job market, be it formal or informal employment.

Before proceeding with the details of the study, it is important briefly explain what constitutes curriculum and competency based education. Curriculum is an essential requirement in any education or training system as it guides planning, conducting and assessing learning processes (Deißinger & Hellwig, 2011). In the context of a school or college, it is the formal and informal contents and processes by which learners acquire knowledge and understanding, develop skills, and alter attitudes, appreciations, and values with the help and support of a given school or any other educational institution (Doll, 1978). A curriculum can either be content or competent based; a content based curriculum focuses on the rote memorization of factual knowledge while competence based curriculum is centred on competence based learning which focuses on understanding the concepts, skills and competencies which requires teaching, learning and assessment approaches (Posner, 1995).

On the other hand, Competence based education emerged for the first time in the United States of America in the early 1970s (Richard & Rogers, 2001). This kind of educational defined educational goals in terms of precise measurable descriptions of knowledge, skills, and attitudes which had to be acquired by students at the end of the course of study, Adeshina (2016). Thereafter, it spread into European countries such as the United Kingdom and Germany in the 1980s (Wolf, 2001). In Sub-Saharan Africa, the adoption of Competency Based Curriculum (CBC) stressed two major purposes namely: the need of changing curriculum contents to make them more relevant both in local and global contexts in terms of desirable competences for the work situation and for everyday life; and changing the teaching-learning process into more learner-centred approaches, Nikolov et al.(2014).

Studies on Assessment and relevance of English communication Skills syllabus in a given programme requires the general understanding the characteristics of the curriculum that is

based on competency based and knowledge based framework.

A curriculum, course or program of training to become a competency-based requires studying various teaching and learning theories that focus on learning outcomes with specific, measurable definitions of knowledge, skill and learner behavior (Tambwe, (2017). Competency based curriculum (CBC) measures what participants have learned as opposed to what instructors think they have taught, Nzima, (2016).

Learning outcomes in a CBC are written for the students and they state what are expected to have learned the targeted students; the outcomes are specific, observable, and measurable and they should be linked with occupational or professional requirements. CBC planners are required to analyze job profiles using incumbent workers of a given industry or an experienced Human Resources Manager of a relevant professional organization rather than the disciplinary 'body of knowledge' (NACTE, 2015).

In an effective CBC, contents are organized in a logical order from simple to complex should be organized in a logical order from simple to complex (Kirschner et al., 1997). Another characteristic of a CBC is modularizing the curriculum contents through which the learning outcomes that form a coherent compatibility for specific competence are clustered to form modules to be assessed independently. The modules have to be organized in a logical sequence for the realization of the intended competencies and allocating them into semesters because some modules need to be covered before others (NACTE, 2015; Kouwenhoven, 2003).

Other characteristics of CBC include: it is based on the future occupational practice of the graduate (Boyatzis et al., 1996); it is learner-centered and the learning process is central, it uses individualized materials, flexible learning time and a continuous feedback to the learner (Field & Drysdale, 1991). CBE is based on the constructivist approach the main goal of constructivism is competence, not knowledge as in cognitivism, or achievement as in behaviorism (Kouwenhoven, 2003).

In terms of assessment, a CBC focuses on the ability of a learner to know, to learn as well as learning how to learn, to do things, and working with other people (Mosha, 2012). It requires a pedagogical shift from assessing a set of learning contents to assessing each

learning outcome (Rutayuga, 2010).

Another aspect that need to be attended in this review is the issue of competency based training and the expectation of the graduands in law programme in Tanzania. Diploma in Law students in Tanzania after graduation are expected to be admitted to degree programme, to engage in self-employment and other to be employed in the judiciary as a court clerk and other related law firm, Decorte (1994). Also they can perform other clerical work in several government ministries and district council. Our review the will focus on this category that the judiciary of Tanzania make use of them as a clerical officers. Therefore, they are expected to competent oriented graduands. Now let us push our discussion by reviewing the literatures that relate to law graduates with job market.

**Jobs of Law Graduates and Duties of Law Clerks.**The legal system affects nearly every aspect of our society and lawyers links between the legal system and the community (Vidyasagar, 2008). Due to that fact, graduates of a Diploma of Law can be employed in a number of occupations, in most cases they are hired as clerks; according to the Black's Law Dictionary, the word clerk means a public official whose duties include keeping records or accounts, in this case, the duties to be provided under this section focuses on law clerks.

The current duties of law clerks are diverse and dependent on the judges to whom they are appointed (Holvast, 2016; Sobel, 2007). Law clerks prepare clear, concise and professionally written communication such as briefs, affidavits, statements of claim using correct spelling, grammar, punctuation, and syntax (MTCU, 2012; Holvast, 2016). They are responsible for conducting legal research, editing and proofreading the judge's orders and opinions, and verify-ing citation (Sobel, 2007).

Moreover, the duties of the clerk do not only begin and end in the courtroom. Apart from preparing documents, the clerks in any court may well see defendants, prosecutors, local solicitors, witnesses outside the courtroom when such people come looking for help and guidance (Astor, 1984). Furthermore, judges discuss pending cases with their law clerks and confer with them about decisions; and district court law clerks often attend conferences in chambers with attorneys as well as send their law clerks to the chambers of other judges to speak with their law clerks to discuss less significant issues that would

occur between the judges directly (Sobel, 2007; Holvast, 2016).

**Communication Skills and the Outcomes Required for the Diploma in Law Graduates to Attain their Duties.** Learning outcomes are about acquiring skills and knowledge, but a CBC requires students to process learning in a way that enables them to apply that skill and knowledge in a variety of situations and to a variety of tasks. Competencies require law schools to develop curricula and assessments where students can demonstrate learning and mastery of practical legal skills and abilities progressively (Mottershead & Magliozzi, 2016).

Legal issues usually consist of a series of communications, both oral and written. One of the language requirements for law clerks is to demonstrate the ability to support the needs of clients and legal professionals through professional communication strategies, in reading, writing, speaking, listening, and presenting (MTCU, 2012; The Judiciary of Ghana, 2011). This is determined by the use of appropriate verbal and non-verbal communication skills within the context of the legal environment, displaying active listening skills in all interactions, and adapting communication strategies according to the needs of the client and/or the legal professional (MTCU, 2012).

Therefore, individuals who wish to prepare adequately for career in law, or for any professional service that involve the use of legal skills, should seek/provided with educational, extracurricular and life experiences that will assist them in developing analytical and problem solving skills, critical reading abilities, oral communication and listening abilities, task organization and management skills, as well as writing skills (Vidyasagar, 2008). The curriculum for Diploma in Law should also enable students to demonstrate the ability to interview, negotiating, counselling, and planning (Pye, 1987).

The experiences in African countries show that it is possible to develop and implement competency-based curricula in a higher education context (Kouwenhoven, 2003). However, more researchers are required to evaluate the effectiveness of CBC and particularly whether such innovations are sustainable when external project funding comes to an end (ibid). In fact, most of the graduates of Diploma in Law in many colleges in Tanzania cannot write effectively, communicate orally, gather facts, manage

interviews, counsel, negotiate, and plan innovative solutions to clients' problems. This necessitated the need to conduct an analytical study to assess the relevance of English communication skills syllabus to Diploma in Law programme in Tanzania to evaluate if it reflects competency-based education and training as expected.

In Tanzania, different reforms have been made since 1995 when the Education and Training Policy was issued (Ryan, 2011). The reviews were basically intended to make a shift from the traditional knowledge based curriculum to competence based curriculum as the old ones were ineffective as the graduates failed to demonstrate the skills and competences that fully addressed local, national and global market demands (Komba and Kira, 2013). In other words, curriculum developers attempt to improve the quality of education by enabling learners to develop the required competences which are relevant in different spheres of life (Ryan, 2011).

As stated by NACTE (2015), the shift from knowledge-based education and training to competency based education system is influenced by the Development Vision 2025, which advocates Tanzania to be a nation with high level of education at all levels and which produces the quantity and quality of people sufficiently equipped with the required knowledge and skills to underpin sustainable development (NACTE, 2015). Due to this need, Tanzanian government has been emphasizing the achievements of the objectives in tertiary education to have an impact on the employability of graduates of various professions and on their competency to enter the private and other sectors of the economy (NACTE, 2015). English communication skills are among of the core skills expected to every graduate in every profession.

The curriculum issued by Ministry of constitutional in Tanzania under umbrella of Legal sector reform programme developed the national legal training curriculum (2010) which presupposes to offer knowledge and skills of legal professionals. In response to developments and challenges that have taken place in the country and elsewhere for the past few years the Government, through the legal Sector Reform Program, resolved to design this national curriculum to provide minimum standards to guide the provision of legal education at all levels in Tanzania. The standards were agreed by stakeholders as best practices in the provision of legal education and are informed by developments taking place at the East African Community level with regard to education generally and

legal education in particular. This is a training programme at an intermediary-pre degree level intended for primary court magistrates, paralegals and other person needing such intermediary legal education. The diploma programme was also meant to provide a bridge between those who have gone through the certificate in law programme and wish to pursue further studies in law. At the end of the programme candidates were expected to have an intermediary knowledge of the law and its application in various settings and circumstances. They must have

- a. Knowledge and understanding of the general legal principles and to be able to apply them to work situations;
- b. Ability to develop an appreciation of the development of the law through legislation, judicial decisions and practice.

However, many higher education institutions experience a growing gap between their curricula and the demands from society, business and industry for a more flexible workforce with competencies in problem solving, team work and project management (Kouwenhoven, 2003). Particularly institutions offering diploma in Law Program produce lawyers who only master English grammar rather than other communication skills which are essential to their profession; most of them cannot write effectively, communicate orally, gather facts, manage interview, counsel, negotiate, and plan innovative solutions to clients' problems. It is due to this challenge, the study wanted to assess relevance of English communication skills syllabus to Diploma in Law programme in Tanzania if it brings competency based education and training as expected. In terms of focus, the study is limited to one public institution: the Institute of Judicial Administration Lushoto, the choice is based to the fact that this institute is only that offers and expected to offer diploma in law programme and expected that the graduands must have the necessary skills for performing judicial clerical duties and other related function in Tanzania. Thus the other thought this institution can be a best for investigation.

## **2.0 METHODOLOGY**

The study used documentary review to collect data and the data were analyzed using descriptive design. Various documents including English Communication Skills syllabus for a Diploma in Law, others include research thesis, articles and books related to the study. The data obtained were presented, interpreted and analyzed regarding the objectives of the study.

**Documentary review: The author reviewed the English communication skills for diploma in law which has the following course contents:**

Contents for diploma syllabus

Describe elements of communication process

Apply different techniques of communication

Describe communication channels

Describe barriers of communication and the **ways** to overcome them

Identify Statutory Sentences in Statutes

Demonstrate skills in analyzing Structural Statutory Clauses in Statutes

Demonstrate Paraphrasing Techniques in Statutory Sentences

Describe steps used in writing bibliographical information

Apply footnotes skills in writing texts

Apply Latin abbreviations used in writing footnotes

Explain the major parts of report

## **3.0 RESULTST AND DISCUSSION**

The study assessed the relevance of English communication skills syllabus to a diploma in law programme in Tanzania if it brings competency-based education and training as expected. The study was based on two objectives, namely, to analyze the English communication skills syllabus to Diploma in Law programme in Tanzania, and to evaluate its reflection in attaining the required competencies to a diploma in law graduates. The study covered one English communication skills syllabus for Diploma in Law Programme, and the following are the findings obtained.

### **3.1 An Analysis of the English Communication Skills Syllabus to a Diploma in Law Programme**

The syllabus contains thirteen outcomes. The first outcome is to describe elements of a communication process. The outcome comprises three related tasks such as to explain communication process, to explain elements of the communication process, and to outline the importance of communication process.

The second outcome is to apply different techniques of communication. The outcome has three related tasks such as explaining techniques of communication, using communication techniques (sign, body language, oral, and written); and outlining the techniques of communication.

The third outcome is to describe communication channels. It has three related tasks: explaining the general concept of the communication channel, explaining aspects of communication channel, and outlining the communication channels.

The fourth outcome is to describe barriers of communication and ways to overcome them; the outcome contains three related tasks such as explaining the meaning of communication barriers, describing communication barriers and outlining the barriers of a communication process.

The fifth outcome is to identify statutory sentences in statutes; it comprises three related tasks: defining statutory sentences, identifying core, statement, qualifications, and conditions in statutory sentences, and outlining the techniques used in analyzing statutory sentences.

The sixth outcome is to demonstrate skills in analyzing structural statutory clauses in statutes; identifying binominal expressions in statutory sentences; analyzing structural statutory clauses, and explaining the importance of analyzing statutory clauses.

The seventh outcome is to demonstrate paraphrasing techniques in statutory sentences; it involves three related tasks: explaining paraphrasing the techniques, identifying major terms shorten the statutory sentences, and outlining the techniques used in paraphrasing statutory sentences.

The eighth outcome is to describe steps used in writing bibliographical information. It involves four related tasks: explaining steps for writing bibliographical information for textbooks, journals, manuals, newspapers; outlining the steps for writing proper textbooks and journal bibliographical list, outlining the steps for writing manual and newspaper bibliographical list, and describing the advantages and disadvantages of

acknowledgment in academic writing.

The ninth outcome is to apply footnotes skills in writing texts. It comprises three related tasks such as describing footnotes writing procedures, differentiates between American Method style from footnotes style, and explaining the importance of using footnotes style to a law student footnotes skills are correctly described and explained.

The tenth outcome is to apply Latin abbreviations used in writing footnotes. It involves four related tasks, namely, describing Latin abbreviations used in writing footnotes, differentiating the term Ibid from Op.cit., as frequently used in footnotes writing, outlining the major Latin abbreviations frequently used in footnotes, and explaining the importance of Latin abbreviations in footnotes.

The eleventh outcome is to explain the major parts of a report. It comprises four related tasks: describing major parts of the report, describe the front matter, explain the main body, and differentiating between the front matter and main body.

The twelfth outcome is to describe the elements of the report. It has four related tasks: explaining the elements of reports (front matter, main body, and back matter); describing the elements of the front matter, describing the elements of the main body, as well as comparing and contrasting between front matter and the main body.

The thirteenth and last outcome is to describe the back matter of the reports. It includes four related tasks: explaining the components of the back matter, comparing between the front matter and the back matter, outlining the main elements of the back matter, explaining the importance of the back matter in reports, and components of the back matter are correctly explained.

All of the thirteen learning outcomes and their related tasks will be assessed using written test, assignments, and oral questing methods.

### **3.2 Discussions and Evaluation of the Reflection of the English Communication Skills Syllabus in attaining the required Competencies to a Diploma in Law Graduates**

From the Analysis of the English Communication Skills Syllabus to Diploma in Law Programme, the study evaluated if the syllabus is based on competencies enough attain the required competencies to a Diploma in Law Graduates observed strengths and

weaknesses as follows.

### **3.2.1 Strengths of the English Communication skills syllabus in attaining the required competencies to a diploma in law graduates**

The syllabus focuses on enabling the diploma in law students to acquire writing communication skills. On one hand, the syllabus intends to equip learners with writing skills related to legal profession such as footnotes skills in writing texts, steps used in writing bibliographical information, Latin abbreviations used in writing footnotes, paraphrasing techniques in statutory sentences, and knowledge on the major parts, elements and the back matter of the reports. This concurs with the claim by Holvast (2016) that Law clerks prepare clear, concise and professionally written communication such as briefs, affidavits, statements of claim using correct spelling, grammar, punctuation, and syntax.

The syllabus intends to equip the learners with knowledge on different issues related to oral communications skills such as the elements and importance of communication process, techniques of communication, using communication techniques and channels, and barriers of communication and ways to overcome them. This is relevant to the claim that a CBC should assist them in developing analytical and problem-solving skills, critical reading abilities, oral communication and listening abilities, task organization, and management skills, as well as writing skills (Vidyasagar, 2008).

Moreover, the contents of the syllabus are logically arranged from simple to complex. It begins with elements of communication process, techniques of communication, communication channels, barriers of communication and ways to overcome them, statutory sentences in statutes, skills in analyzing structural statutory clauses in statutes, paraphrasing techniques in statutory sentences, steps used in writing bibliographical information, footnotes skills in writing texts, Latin abbreviations used in writing footnotes, major parts of report, elements of the report, back matter of the reports. This is relevant to Kirschner et al (1997) that contents in an effective CBC are organized in a logical order from simple to complex should be organized in a logical order from simple to complex.

### **3.2.2 Weaknesses of the English Communication Skills Syllabus in Attaining the Required Competencies to Diploma in Law Graduates**

Despite the strengths, the reviewed syllabus has some weaknesses that make it irrelevant to a Competency-Based Curriculum.

It not explicitly aligned with expected competencies; it does not provide detailed information about the intended interpretations and how the suggested assessments will be used. This does not concur with McClarty & Gaertner (2015) that competencies must be clearly defined, measurable, and related to the knowledge or skills needed for future endeavors, specific to a particular course or program.

The contents of the syllabus are not well modularized; the contents are not clustered in modules to form a coherent compatibility for specific competencies to be learned independently. This is contrary to NACTE (2015) that the curriculum contents through which the learning outcomes that form a coherent compatibility for specific competence should be organized in a logical sequence for the realization of the intended competencies and allocating them into semesters because some modules need to be covered before others.

The syllabus does not suggest appropriate instructional materials; a CBC is supposed to suggest instructional materials to make course instructors aware of the appropriate materials to competency-based learning. The syllabus is contrary to Tambwe (2017) that to ensure that curriculum and assessment are implemented properly, educators must consider developing appropriate instructional materials to support learning activities. In addition, teachers will need to be trained on how to use the new materials since the methodology of CBET system requires shifting from teacher to student-centered approach.

It does indicate professional communication strategies to enable graduates to meet the needs of their profession. The syllabus contains general communication skills like communication channels and barriers to communication without specifying the legal communication skills. This is contrary to the Judiciary of Ghana (2011) which stresses that one of the language requirements for law clerks is to demonstrate the ability to support the needs of clients and legal professionals through professional communication strategies, in reading, writing, speaking, listening, and presenting.

The syllabus does not suggest different tasks on different occasions to enable graduates to apply the acquired knowledge in different circumstances. It is clear that CBC requires

students to process learning in a way that enables them to apply the acquired skills and knowledge in a variety of situations and to a variety of tasks. Karameta (n.d) suggests that neglecting situations and actions of the person in the situation, to notify promptly, generalized competence lists (out of context) is nonsense because any competency by nature is a function of the action of a person in the situation. Action and situation are essential to a competency-based approach; however, new programs lack both these elements.

The syllabus does not suggest appropriate assessment methods; uses the same methods, which is, written test, assignment, and oral questioning methods in each outcome. In this sense, the assessment methods suggested can imply that the curriculum will be implemented without learning practices. This does not concur with the claim by Kouwenhoven (2003) that knowledge in CBE supports the development of competencies and that the acquisition of knowledge takes place in the context of (professional) application which includes learning assignments and learning practices.

The syllabus only recognizes skills rather than competencies; it starts with the outline of the so-called “sub-outcome” but no any competencies that are mentioned. This is a challenge because course instructors will focus on contents to meet the outcomes without focusing to enable learners to apply the acquired skills and knowledge. According to Kouwenhoven (2003), a CBC is based on the elaboration of profiles and identification of competencies. Domain-specific knowledge and skills are determined by the competencies that are needed by a competent professional and not by the disciplinary ‘body of knowledge’.

The syllabus does not suggest field assessment; In Non-formal education program not only writing, reading and accounting is taught, but also the learners achieve the ability to solve personal and social problems. Assessment of achievement concerning these areas will never be possible in classrooms. It is only possible if we can assess our learners in their real situation. Concerned persons or co-learners may properly assess each other’s progress. So nowadays in assessing the progress of the learners, much importance is given to the participatory assessment system. EDIT

The syllabus is too inappropriate to enable learners to be confident to attain their expected duties; since the whole syllabus focuses on knowledge and skills acquisition

only within the classroom, some learners will not be able to be confident enough to fulfill their duties like guidance and counseling skills. Astor (1984) asserts that apart from preparing documents, the clerks in any court may well see defendants, prosecutors, local solicitors, witnesses outside the courtroom when such people come looking for help and guidance. Also, Pye (1987) adds that the curriculum for Diploma in Law should also enable students to demonstrate the ability to interview, negotiating, counseling, and planning.

#### **4.0. CONCLUSIONS**

The paper dealt with the assessment of the relevance of English communication skills syllabus to Diploma in Law programme in Tanzania if it brings competency-based education and training as expected. The findings reveal that the syllabus that was evaluated is not relevant to a Competency-Based Curriculum as it lacks essential characteristics of the CBC, hence it does not reflect the ability to attain the required competencies to a diploma in law graduates. An effective competency-based English communication skills curriculum for a Diploma in Law program should comprise relevant contents, in this case, legal communication strategies such as strategies, in reading, writing, speaking, listening, and presenting skills in legal context, it should be clearly stated, the contents should be clustered in modules to form a coherent compatibility for specific competencies to be learned independently, should consider functions of competencies in different legal situations. It should be suggesting appropriate assessment methods like collaborative tasks which will enable learners to perform in a participatory way, and appropriate instructional materials should be suggested to support learning activities.

Also the paper has presented an assessment of the relevance of English communication skills syllabus to Diploma in Law program in Tanzania. The paper concludes that the Diploma in Law curriculum is designed to focus knowledge and skills rather than demonstrating the ability to apply them. In fact, the curriculum is unrealistic and it is contrary to the expectations of producing graduates with competency-based education and training, and it will continue to be far from reality unless the contents, instructional methods, assessment methods, and training focus is changed and linked to the

professional profiles.

## **5.0 RECOMMENDATIONS**

For effectiveness, the paper recommends that the responsible organs such as the National Council for Technical Education (NACTE) should organize improvement and harmonize the English communication skills for a diploma in law programme by conducting several workshops on the methodology of implementing the competency-based teaching, appropriate instructional materials, assessment methods as well as qualities of a good competency-based curriculum.

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## **Translated Kiswahili Texts: A Case Study of Kithaka Wamberia's Texts.**

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### **ABSTRACT**

Translation is a complex exercise that involves not only transfer of meaning of linguistic aspects of translated texts but more importantly their literary aspects. This means that as Omboga 2006:50 observes a translator must of primary importance understand the historical, social and geographical contexts of the target audience so as to come up with the translated text that meets their knowledge, expectations and values. This paper examined the plays written by Kithaka wa Mberia in Kiswahili and translated in English with a view by the writer to reach a wider audience. We have assessed the themes presented, linguistic and stylistic devices employed and the characters presented to see whether the knowledge, expectations and values of the target audience are met. Given that these texts are originally written in Kiswahili, it was important to see how the translator conveys the message to the wider audience targeted by the choice of use of English language. In our analysis we employed the Skopos theory of translation which focuses on translation as a purposive activity intended for a particular audience. The conclusion is that the translated texts have not to a great extent conveyed the intended message to the audience targeted as the translators focused mainly on the linguistic equivalents and to a large extent failed to meet the knowledge, expectations and values of the wider audience targeted.

### **1.0 INTRODUCTION.**

Kiswahili literature boasts a wealth of translated texts from many languages and cultures following its long contacts and interactions with equally many literacy and cultural traditions. Since the advent of written literature in Kiswahili, which may be put anywhere between 1500-1662AD ( Wamitila 2001: 24), the translation of literary texts into Kiswahili has played an important role in the development of Kiswahili literature. Consequently, over the years, literary translation has become an academic and scholarly pursuit that arouses a lot of interest as well as controversy among scholars and critics of Kiswahili literature.

Many studies have focused on the strengths and weaknesses of translated texts as well as methodological and linguistic flaws exhibited by texts. However, most of what has been

written on literary translation in Kiswahili is characterized by preoccupation with the texts written in other languages then translated in Kiswahili with a view of checking the linguistic equivalents with the source text. The texts written originally in Kiswahili then translated into other languages has not been given a lot of emphasis.

The first known translations were poems located in Arabic literary, cultural and historical contexts such as *Alfu Lela Ulela*, *Hamziya* and *utendi wa Tambuka* just to mention a few. (Omboga 2006:25-26) Kiswahili literature has also received translated texts from Greek such as *Mfalme Edipode*, *Russia-Mkaguzi Mkuu wa Serikali*, *Finish-utenzi wa Kalevala*, *Portuguese-Chagua Maisha*, *English-Mabepari wa Venisi* among many others. It also hosts translations from African authors like Kitereza A. *Bwana Myombekere na Bibi Bugonoko*, *wimbo wa Lawino Okot Bitek*, *Shetani Msalabani* by Ngugi wa Thiongo.

The translation of literary texts from various historical and cultural backgrounds is evidence of an intense literary and cultural interaction between Kiswahili and other languages and cultures. This has expanded and enriched Kiswahili literature to the extent that today many Kiswahili texts are being translated in other languages which has continued to expand and enrich Kiswahili literature and make it reach a more wider audience. It is with this in mind that this paper examines selected Kiswahili texts written by Kithaka wa Mberia and translated in English language by other writers. We will examine whether the translated texts have the same themes, how the Characters have been portrayed and how the literary devices have been employed to convey the message in the original texts to the target audience in specific circumstances.

This study will be guided by Skopos theory which focuses on translation as an activity with a purpose that is intended to an audience. To translate means to produce a target text in target audience in target circumstances. It then follows that the function of translation depends on the knowledge, expectations, values and norms of target readers who are influenced by the state they are in and by culture. Thus the translated text must be internally coherent, it must also be coherent with source text and the translated text is determined by its skopos.

### **1.1 *Flowers in the Morning Sun* ( Kasu & Marani 2011) Translation of *Maua Kwenye Jua la Asubuhi* ( Mberia 2004 )**

*Flowers in the morning sun* is a play which talks about the two ethnic communities

Ndikus and Tanges who are fighting each other as result of incitement by their leaders so as to achieve political goals. The Ndikus led by Chebwe and Toiche keep on attacking the Tanges led by Kabitho and Tungai who are ready to defend themselves using any possible means. Kabitho is advancing his theory that should they be attacked they should not only attack the attackers who armed but also kill innocent women and children. Tungai who is a retired military officer is opposed to that and even he opposes the use of children in the war against their enemy. Waito and Nali who are young and belong to different ethnic communities manage to convince the two communities to keep peace and avoid a bloody conflict stage managed by the leaders Chebwe and Kabitho for their own selfish ends. Thus they are flowers in the morning sun because as different flowers grow in the same garden each beautiful in its own day then there is a possibility different ethnic communities can live together harmoniously.

The themes of conventions of war, ethnic animosity, bad governance, family relationships, class interrelationships and abuse of office are well presented to a large extent as it is in the original Kiswahili text. This comes out well when Kabitho and Tungai are talking about involvement of children in the war and Tungai who is a retired soldier says:

No Kabitho! Its not right to destroy the lives of children. Once children get involved in ravages of war, once they get introduced to drugs, they no longer have hope in life.....pg 50.

There is talk of Richard Taylor and Richard Taylor Sankoh who both used the children in the war, The National Army of Sudan who were at war with the southern inhabitants but amidst all this Tungai maintains that International Humanitarian Law must be followed as stipulated in the Geneva convention. Bad governance comes out well when Chebwe instigates tribal conflicts so as to win the forthcoming elections and also retain large tracts of land after evicting the Tanges. In all this the citizens continue suffering as they are killed, maimed and displaced in their own country. The hope lies with a few people like Waito, Nali and Neche who are ready to stop these activities and live harmoniously with their neighbours.

A translated text must produce a target text in target addresses in target circumstances

for its message to be well understood. It must keep in mind the historical and geographical context of the target audience for it to communicate effectively. The original text in this case is set in an African setting as the issue of ethnic conflict is more pronounced in African countries. There is mention of war in Liberia and Sudan which are African countries. It is our view that for the translated text which is aimed at a wider audience of the whole world as the translator says that the translation was commissioned and funded by International Committee of Red cross to disseminate the tenets of the international Humanitarian Law, the translator should have included aspects of real war than just the ethnic clashes between two communities. The translated text should have been expanded in scope to include wars in Iraq, Afghanistan, North Korea and other European countries to underscore the fact that the tenets International Humanitarian Law are meant for the whole world and not African countries only.

On the same vein, the translated text should have included aspects of International Criminal Court for it to be widely appreciated. This is because the function of translation depends on the knowledge, expectations, values and norms of the target readers who are influenced by the situation they are in and by culture.( Malangwa 2014:107). Thus while it's true that the themes are to a certain extent well presented as in the original text, the translated text fails to capture to a large extent the knowledge, expectations and values of the target audience by limiting the main plot to two ethnic communities and mentioning only some African countries who have been at war and excluding the aspects of International Criminal justice system and as Omboga asserts translation is a creative act in which the translated text participates in the creation of knowledge and by extension power....it participates in its own creation.(Omboga2006:91). The process of translation is a process of gathering new and creating new information to make it well understood and appreciated by the target audience in their specific context and time.

The translated text must use language that communicates the equivalence of the original text. One of the major problems of translation is the disparity among languages. The bigger the gap between the source language and translated language the more difficult the transfer of the message will be. Momanyi asserts that literary

texts are very challenging to translate because the texts are creative works and are written in artistic language. Thus the translator must understand the linguistic differences, ideologies, history and the context. (Momanyi 2012:29)

The language used in the *Flowers in the Morning Sun* to a large extent communicates the message to the target audience. However the imagery used in the title *Maua Kwenye Jua La Asubuhi* is translated as *Flowers in the Morning Sun* is misleading as it is translated word for word. There are also many phrases and proverbs that are not well translated and thus the main message is lost to a certain extent. Some of these include; *silaha za kienyenji* -crude weapons pg1, *hakuna marefu yasiyo na mwisho* -nothing lasts forever pg1, *baridi inayochoma kama moto*-biting cold that stings ones lungs pg3, *lugha nyororo*-polite language pg 3, *tuhurumie ewe mola* -take pity on us, Good Lord pg5, *baadhi ya magazeti*-sections of the local media pg 6, *damu ya kabila letu*-our people pg 9, *kuanza mapema*-early bird catches the worm pg 11 and many others throughout the text. These examples show that to a large extent the translated text has got many phrases and other linguistic and stylistic devices that don't capture the real intent and touch of the original text. The ethnic rivalry brought out by the use of Kiswahili original phrases like *yalimwaga maiti mfano wa mti umwagavyo majani makavu chini wakati wa upepo mkali* pg 52 *bado tunapambana na mlima* pg 53, *sura zao zinaudhi kama tamaa yao ya mali* pg 54 is lacking. Also the language used in the translated text does not meet the expectations of the target audience to a large extent because if the target audience is international the readers, they would expect equivalent linguistic and stylistic devices which is not the case. Most of these are just translated word for word either distorting the meanings or losing it all together. Generally the message is not well conveyed to the target audience of the wider world. It appears as if the text is translated for only Africans in general and Kiswahili speakers in particular, rather than the international community which is the target audience.

The characters in the translated text are presented as they are in the original text. There names are like Kabitho, Toiche, Chebwe, Tungai just to name a few. This makes the text appear as though the target audience is people of African communities. Furthermore their social settings seem to be in Africa where Chebwe is lying to the

wife he had travelled to Tanzania yet he was busy inciting his tribesmen, Kabitho is buying arrows and Matchettes for war, warriors are being trained in the forest, Tungai is a retired soldier who even didn't return all military uniforms as required and many others. This makes the characters historical and social context not resonate well with the target audience since even the champions of peace Waito and Naila are not ideologically shown to have the knowledge and capacity to champion international peace. However the characters are well placed in the African setting and so to a large extent the fidelity to the original text is preserved to a great extent.

In general the translated text *flowers in the morning sun* largely is consistent and coherent with the original text in content, themes, linguistic devices and characterization. However by failing to consider the linguistic, cultural, historical and geographical contexts of the target audience the translated text fails to convey the message and themes of tenets and conventions of war well to the target audience which is the international community.

## **1.2 *Death at the Well* (Kasu & Marami 2011) Translation of *Kifo Kisimani* (Mberia 2001 ).**

*Death at the well* is a play set in an imaginary African society named Butangi. The society is led by Bokono who exhibits dictatorial tendencies, corruption, political patronage, violation of human rights among other aspects of bad governance. Mwelusi a young man of 24 years foments a rebellion but is killed by his brother Gege. His death leads to a major rebellion where Bokono's government is brought down by use of force.

The themes that are shown in the play include bad governance, looting of public resources, patriotism, human freedoms, betrayal, family relationships, class interrelationships and abuse of office are well presented to a large extent as it is in the original Kiswahili text. This comes out well when Bokono and Nyalwe are talking and Nyalwe says:

Bad governance! Its time you stopped engaging in acts that distress the people pg17.

The context here is that Bokono was really disturbed after a meeting he had called failed to materialise. There is talk between Mwelusi and Gege later which shows Mwelusi is very much aware of the bad governance and its effects pg 50-51. Bad

governance also comes out well when Batu and other Bokono instigates tribal conflicts so as to instil fear among the citizen like Azena. In all this the citizens continue suffering as they are killed, maimed and tortured in their own country. The hope lies with a few people like Mwelusi and Atega who are well informed, ideologically firm, who are ready to stop these activities as they lead a strong rebellion against an oppressive regime which is set to cling to power using all means possible including death the way Mwelusi is killed. The warning to these dictators like Bokono is that killing leaders only serves to strengthen dissent and rebellion thus finally Bokono's Government is brought down by the use of force.

As mentioned earlier a translated text must produce a target text in target addresses in target circumstances for its message to be well understood. It must keep in mind the historical and geographical context of the target audience for it to communicate effectively. The original text in this case is set in an African setting as the issue of bad governance characterised by dictatorship and sycophancy is more pronounced in African countries. We submit that for the translated text which is aimed at a wider audience of the whole world, the translator should have included aspects of bad governance to reflect the dictators of the world like Saddam Hussein of Iraq, Adolf Hitler of Germany among others. The translated text should have been expanded in scope to underscore the fact that the tenets of bad governance are not only confined in Africa but are exemplified all over the world because the target audience of the English translation is much wider it is meant for the whole world and not African countries only.

On the same vein, the translated text should have included aspects of a proper and well organized government led by Bokono that can be widely appreciated by the wider audience which the target translation is targeting. This is because the function of translation depends on the knowledge, expectations, values and norms of the target readers who are influenced by the situation they are in and by culture (Malangwa 2014:107). Thus for example it is difficult for a wider audience to conceive government led by a chief like Chief Bokono and a few elders like Batu. While it's true that the themes are to a certain extent well presented as in the original text, the translated text fails to capture to a large extent the knowledge, expectations and

values of the target audience by limiting the main plot to an imaginative village in Africa which is led by a chief and a few elders and advisors and a prison guarded by spears and arrows which are not even ready in spite of the looming rebellion and insurgency led by Mwelusi.

Omboga asserts that translation is a creative act in which the translated text participates in the creation of knowledge and by extension power....it participates in its own creation. (Omboga2006:9)<sup>1</sup>. The process of translation is a process of gathering new and creating new information to make it well understood and appreciated by the target audience in their specific context and time. Thus it's our view that the translated text should have been recreated so as to convey the message to a wider world audience for the themes to be well understood like for example instead of Chief Bokono they should have used King or President Bokono in the translated text.

Momanyi asserts that literary texts are very challenging to translate because the texts are creative works and are written in artistic language. Thus the translator must understand the linguistic differences, ideologies, history and the context. (Momanyi 2012:15) The language used in the *Death at The Well* to a large extent communicates the message to the target audience. However the imagery used in the title *Kifo Kisimani* translated as *Death at the Well* is misleading as it is translated word for word. There are also many phrases and proverbs that are not well translated and thus the main message is lost. Some of these include; *nimeamka vizuri nashukuru* –it's well with me, I thank the Good Lord pg1, *hivi ni viti vizuri* -these are beautiful chairs, pg2, *shikamooni* -Good morning ladies, *Ni wazalendo thabiti kama majabali* -their loyalty is beyond reproach, *sikio la kufa halisikii dawa* -those that are hellbent on dying never respond to medication, *mkate wa wishwa* -bran cake pg 63 among others. These examples show that to a large extent the translated text has got many phrases and other linguistic and stylistic devices that don't capture the real intent and touch of the original text. Also the language used in the translated text does not meet the expectations of the target audience because if the target audience is international the readers, they would expect equivalent linguistic and stylistic devices like King Bokono or President Bokono rather than Chief Bokono. Most of these are just

translated word for word either distorting the meanings or losing it all together. Generally the message is not well conveyed to the target audience of the wider world. It appears as if the text is translated for only African audience in general and Kiswahili speakers in particular rather than the international community which is the target audience.

The characters in the translated text are presented as they are in the original text. Their names are like Bokono, Nyalwe, Mwelusi, Tanya, Gege just to name a few. This makes the text appear as though the target audience is African audience. Furthermore their social and geographical settings seem to be in Africa where Mwelusi and Gege meet at the well of Mkomani and Mwelusi is convinced to go into privacy with him to hear a message from the mother. Gege kills him by stabbing him in the stomach fomenting a rebellion leading an overthrow Bokono's government. The use of knives and axes makes the whole translation look more targeted to African countries rather than the whole world audience. This makes the characters historical and social context not resonate well with the target audience. However the champions of liberation like Mwelusi and Atega are ideologically shown to have the knowledge and capacity to champion a rebellion although their ability to lead using a specific ideology is not well shown including their education and wide grasp of social and economic issues bedevelling the world leaders. However the characters are well placed in the African setting and so to a large extent the fidelity to the original text is largely preserved.

In general the translated text *Death at The Well* largely is consistent and coherent with the original text in content, themes, linguistic devices and characterization. However by failing to consider the linguistic, cultural, historical and geographical contexts of the target audience the translated text fails to convey the message liberation struggles and good governance as exemplified by the world as a whole.

### **1.3 *Natala* (Kasu & Marami 2011) Translation of *Natala* (Mberia 2011)**

*Natala* is a play set in African society which follows traditional and cultural practices that threaten the dignity of a woman. Natala is a widow who has to contend with greedy relatives like Wakene who are out to disinherit her by getting her matrimonial property by conspiracy and force. The society exhibits ignorance, high levels of male

chauvinistic tendencies, corruption, bad governance and violation of human rights among others. Natala a young widow has to fight tooth and nail to protect her property as well as her dignity as human being as well as a woman.

The themes that come out in this play include, women rights, bad governance, human dignity, cultural traditions, human freedoms, betrayal, family relationships among others. In general they are well presented to a large extent as it is in the original Kiswahili text. This comes out well when Natala asks Bala whether he thinks she is a public building doorway through which people randomly stream in and out pg24. This was after the Mortuary attendant insisted on sexual favors from Natala so that he can release the body of her husband for burial. Infact, the mortuary attendant attempts to rape Natala in his office but Natala kicks him down which shows that Natala is ready to fight for her dignity and that of women using any means available.

There is talk between Natala and Wakene that shows that Natala is very much aware of bad customs and traditions like women inheritance and their effects on degrading human dignity especially the dignity of women pg 60-61. Bad governance also comes out well when the chief and the police solicit for bribes and sexual favors as they issue threats to her. It is evident that the chief is actually conspiring with Wakene so as Wakene gets the land from Natala the chief will buy it at a throw away price as they will use government officers to change the title deed. All this shows the citizens mostly widows continue suffering as they are disinherited, dispossessed of their property and stripped of their dignity in the name of tradition and cultural practices which are outdated. The hope lies with a few people like Natala who are well informed, ideologically firm, who are ready to fight and resist all retrogressive traditions and cultural practices. The warning to these male chauvinists like Wakene and the chief is that women are ready to protect their human dignity using any means possible. Those still practicing these practices that demean women must change and accord them their full human rights and respect their human dignity.

As mentioned earlier a translated text must produce a target text in target addresses in target circumstances for its message to be well understood. It must keep in mind the historical and geographical context of the target audience for it to communicate effectively. The original text in this case is set in an African setting as the issue of

outdated traditional and cultural practices which strips women of their dignity is more pronounced in African societies. Our opinion is that for the translated text which is aimed at a wider audience of the whole world, the translator should have included other aspects of women mistreatment rather than traditions alone. The translated text should have been expanded in scope to underscore the fact that the tenets of human dignity violations are not only confined in Africa because of traditional practices but are exemplified all over the world through religions like Christianity and Islam which place a woman second to man, constitution and bad laws that propagate male chauvinism among others. This is because the target audience of the English translation is much wider it is meant for the whole world and not African countries only.

On the same vein, the translated text should have included aspects of a proper and well organized government and institutionalised efforts and policies to end women oppression and practice of outdated practices rather than using Natala alone. This could have been widely appreciated by the wider audience which the target translation is targeting. This is because the function of translation depends on the knowledge, expectations, values and norms of the target readers who are influenced by the situation they are in and by culture. Thus for example it is difficult for a wider audience to conceive a fight led by a lonely woman like Natala can bring real transformation to old age practices and traditions by the community. While it's true that the themes are to a certain extent well presented as in the original text, the translated text fails to capture to a large extent the knowledge, expectations and values of the target audience by limiting the main plot to some African communities and only one woman Natala is showing resistance infact others like Tila, Mama Lime among others are for the traditions.

It's not in contention that translation is a creative act in which the translated text participates in the creation of knowledge and by extension power....it participates in its own creation. (Omboga2006;91).The process of translation is a process of gathering new and creating new information to make it well understood and appreciated by the target audience in their specific context and time. Thus it's our view that the translated text should have been recreated so as to convey the message

to a wider world audience for the themes to be well understood by the wider audience targeted by the translated text.

Momanyi asserts that literary texts are very challenging to translate because the texts are creative works and are written in artistic language. Thus the translator must understand the linguistic differences, ideologies, history and the context. (Momanyi 2012:15). The language used in *Natala* to a large extent communicates the message to the target audience. Reading through the text the message flows well and the play is easily understood. However there are phrases and proverbs that are not well translated and thus the main message is lost. Some of these include; *mnaopiga nguo pasi tuingie*-Hello there!May I come in? pg1, *palipo na moshi hapakosi moto*-where there is smoke....pg3, *uchoyo wako utakuua*-this meanness of yours will bring you to a tragic end pg 5 *chui halisi hawatangazi kucha zao*-genuine leopards don't advertise their claws pg 7,*wakati wa kampeini nitakuwa na mabunda ya shilingi ishirini ishirini*-during the campaign I will be carrying bundles of one hundred notes pg77, *ujane si tafrija*-window hood is a traumatic experience (p g 77)among others. These examples show that to a large extent the translated text has got many phrases and other linguistic and stylistic devices that don't capture the real intent and touch of the original text. Also the language used in the translated text does not meet the expectations of the target audience because if the target audience as international the reader would expect equivalent linguistic and stylistic devices Most of these are just translated word for word either distorting the meanings or losing it all together. Generally the message is not well conveyed to the target audience of the wider world. It appears as if the text if translated for only African audience in general and Kiswahili speakers in particular rather than the international community which is the target audience.

The characters in the translated text are presented as they are in the original text. Their names are like Natala, Wakene, Mama Lime, Tila, Mzee Palipali, Wakene, just to name a few. This makes the text appear as though the target audience is Africans. Futhermore, their social settings seem to be in Africa where elderly men are referred as Mama Lime, Mzee Palipali, Mzee Balu among others. The use of physical fights by Natala to fight the mortuary attendant and Wakene makes the whole translated text

look like the target audience is African communities which are not enlightened rather than the whole world audience. This makes the characters historical and social context not resonate well with the target audience. However the champions of women liberation like Natala are ideologically shown to have the knowledge and capacity to champion a liberation although their ability to lead and change the society using a specific ideology is not well shown including their education and wide grasp of social and economic issues bedevelling the female gender. However the characters are well placed in the African setting and so to a large extent the fidelity to the original text is largely preserved.

In general the translated text *Natala* is largely consistent and coherent with the original text in content, themes, linguistic devices and characterization. However by failing to consider the linguistic, cultural, historical and geographical contexts of the target audience the translated text fails to convey the message women liberation struggles and good cultural and customary practices well enshrined in constitution and other governance structures as a reflection of the wider audience of the whole world which the translated text seeks to reach. .

#### **1.4 CONCLUSION**

In this paper we discussed three plays written by Kithaka wa Mberia into at different times in Kiswahili language which were translated into English language in 2011 by Kasu and Marami with an aim of reaching a wider world audience. We have shown that for a translated work to be of great benefit to the intended audience it has to consider the historical, geographical and social context of the target audience since translation of creative work is creativity in itself. By using three plays we have looked at the themes presented in the translated texts, the language and stylistic devices used and how the characters are presented in relation to the source texts.

It is evident that the translators in all the three plays to a large extent sought to present the themes as exactly as presented in the source texts. It is observed that since the target audience of the original text is actually different from the target audience of the translated texts which target audience is the whole world, the themes as presented may not be largely understood and appreciated due to different historical and social contexts. There is need for the translators to widen the scope and recreate the texts to

make the themes more acceptable and well understood by their target audience.

On the use of language and stylistic devices there is wide use of direct translation and lack of use of equivalent stylistic devices making the texts lose the touch with the original texts. However, the plain meaning of the texts comes out although the artistic aspect is largely lost. Characters are also not well placed in the social, historical geographical contexts of the target audience as should be in the translated texts as the translators sought to be loyal to the original texts thus making it harder for target audience of the world to understand. However readers who have African roots will find it not difficult to understand the texts. It's however observed that had the translators focused on the target audience, historical and social settings they would have come out with more widely accepted and understood texts by the target audience since translation of literary works in itself is creative work not merely transfer of linguistic equivalence but also literary equivalence.

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## **Development of emblems for longevity for county governments in Kenya**

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### **ABSTRACT**

The emergence of county governments in Kenya has seen the development of emblems for each county. These emblems exhibit the spirit of the counties, however they cannot be said to be successful because they are not well executed, do not adhere to the principles of heraldry and are not registered. A coat of arms, logo or emblem, can fail in its object if its spirit is not shared, when the design elements are not well executed and do not communicate. Heraldry, is a symbolic language used by institutions as an embodiment of their heritage, achievements and aspirations. The design typically has a shield, helmet and crest and may include other things. Once registered, the herald has authority. Countries without heraldic authorities to grant arms, usually invoke copyright laws to protect and coat of arms, emblems and logos that serve similar purpose. In Africa, the Egyptian pharaohs and Adinkra community for example, were identified by symbols that are heraldic. In Kenya, some of the common symbols or imagery that have been applied include animals, vegetation and people. Using a sample of 5 counties this paper analyses the emblem and the extent to which they serve their heraldic and design functions. The paper is mainly qualitative and the findings are presented under specific headings . It is proposed that guidelines or policy be developed to align the county emblems.

**Key words:** Design, Coat of arms, emblems, heraldry, county governments.

### **Introduction**

An emblem is a visual identity that expresses certain elements of communication between persons and communities in a specific manner. It is a graphic representation of elements held together in a specific style that is fashioned around the principles of heraldry. The elements include drawings, colour, texture, artefacts, environmental aspects such as mountains, water or vegetation. Emblems, once developed are registered within their jurisdictions for protection and also to guard against duplication and misuse. Related to emblems are coat of arms and logos. The Coat of arms bears more authority while logos

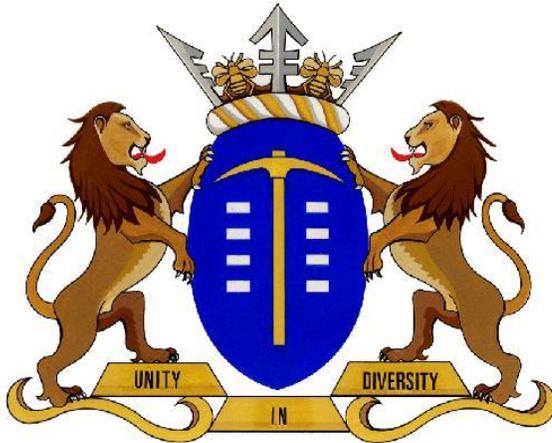
carry much less authority.

There are several legal provisions in the Laws of Kenya that provide guidelines for the use, development and design of Coat of Arms. These include the College of Arms act of 1968, the Act No. 2 of 2002 and the Emblems and Names Act (CAP 99) of 2012. The 2012 Act is, "An Act of Parliament to prevent the improper use of the National Flag and of certain emblems, names, words and likenesses for professional and commercial purposes, and to prohibit the display of certain flags." All the counties adopted this Act as part of recognition of their new status as government with authority.

In South Africa, a provincial Coat of arms is the highest visual symbol of a province that operates very much like the Kenya county governments except that there are 9 provinces unlike the 47 counties in Kenya. The design and development of their coat of arms, badges, emblems and other accessories followed a process that involved several institutions and stakeholders after which the designs were registered and protected under the Heraldry (Act No. 18 of 1962). The act defines 'Coat of Arms' as '...any object or figure being a symbolic representation displayed in colours on a shield in conformity with the principles and rules of Heraldry, with or without a crown, helmet, crest, mantling supporters, motto or other accessories.' In the absence of a Coat of Arms, then there is reference of emblems, that include 'pennant, gonfalon, decoration, medal, seal, insignia of rank, any official rank...or kindred symbolic representation,' (National and Provincial Symbols, South Africa). Detail of the Coat of arms are registered. 'Damages and misuse of registered heraldic representations, names, special names for uniforms' and penalties that arise from misuse are spelt out in the Act.

The design process for example, in Gauteng Province in South Africa involved the Department of Arts, Culture, Science and Technology requesting for ideas from the general public. With additional input from the Cabinet, a brief was drafted and sent to a few agencies identified through the Design South Africa. The ideas were presented to the Cabinet who settled on one. The final Coat of Arms that was registered is full of meaning from the blue shield, to the gold colour and cornet. Two lions support the shield, and on

the banner below is the motto, 'Unity in Diversity.' It may be noted that the name of the province is not part of the Coat of arms as can be seen in Figure 1.



**Figure 2: Gauteng Province Coat of arms**

Institutions involved in the design process for Gauteng Province, for example, included the Department of Arts, Culture, Science and Technology, the Cabinet, the Government Communication and Information System (GCIS) and the Design South Africa and professional designers.

### **The research questions**

For the development of county emblems in Kenya, several approaches may have been used, however, the emblems are not serving their purpose effectively; do not adhere to design principles and heraldic principles. Research has not been undertaken to establish the most appropriate development process that guarantees acceptable Coat of arms. This paper attempts to answer the questions below:

- a. What was considered in the design and development of the emblems?
- b. Were there any policy guidelines provided for the design and development of the emblems?

- c. Were design professionals or institutions involved in the design and development of the emblems?
- d. Are the Coats of arms registered and grant issued by the College of arms?

## **Methodology**

This paper is an exploratory exposition that attempts to highlight the process of design and development of Coat of arms that can serve multiple purposes. The author is informed by several years of professional design practice, research and training. The paper responds to voices of dissent that are rising against some of the emblems that have been developed for the counties. data was collected mainly using secondary sources. However, discussions with professional designers drawn from alumni of the universities in Kenya was held. They are also members of Design Kenya Society that is one of the professional design associations in Kenya that aims to promote professional practice and lobbies for more recognition of design as a key driver for economic growth.

## **The Kenya Government Coat of arms**

With the promulgation of the new constitution in 2010 and the creation of 47 county governments, many of them sought to hurriedly develop visual identities that used the National coat of arms or emblem (Figure 2) as a reference point with the two lions, flag in the middle and a *motto* at the base. Up to that time, the Government Printers were the only authorised printers for all government documents. The use of one appointed printer ensured the reproduction and adherence to certain guidelines on use of Coat of arms. However, this monopoly was revoked to allow other business entities benefit from government printing tenders. As a result, it was noted that, "What has suffered badly since, is the misapplication of usage guidelines. Perhaps the worst thing that design can bring to an official document, is to make it unofficial," (ARK, <http://arkafrica.com>). To illustrate the misapplication, the ARK agency put the two representations side by side (see Figure 2).

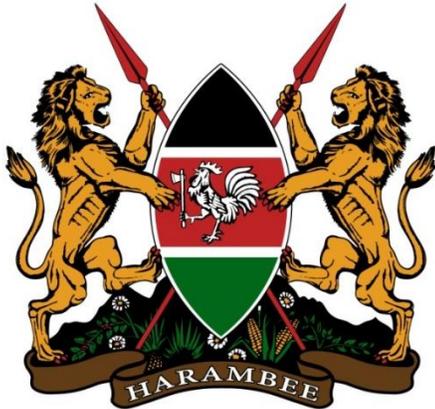


**Figure 3: Two presentations of the coat of arms.**

The Coat of arms on the right side uses the heraldic lion representation with flamed tails. On the left is the "African" lion version with black manes and clawed feet. The colour hues is also markedly different whereas on the right, the lions are more golden in colour and the green is "richer" and the background at the base is more red, on the left, there is a more pronounced yellow, a paler green and the background at the base is brown. These flaws in design amount to misrepresentation. Pantone Colour chart, a global colour reference library, provides a coded guide for the over 5,000 colours for standardized colour reproduction. Each colour has a code for example PANTONE 18-3838 Ultra Violet ([www.pantone-colours.com](http://www.pantone-colours.com)) that has been declared the colour of the year 2018. It may be noted that the county emblems have little consideration for colours and colour combinations. Those that have registered Coat of arms, have not registered the colours according to the pantone range. The registration in this case is important because it guides designers and printers during reproduction and representation.

The ARK, a branding company, proceeded to provide an accurate copy of the Kenya Coat of arms for public use that "allows the rich and meaningful detail of the elements of the Coat of arms" for use in print and digital applications. One major element that ARK corrected was the two lions from the heraldic lions to the African lions. The misapplication of the National Coat of arms, is one of the signs of derision of design principles. ARK decried that, "the misrepresentation of the Coat of arms - the state's logo, so to speak – reflects badly on us. It results in diluting the authority of the agency or

office involved, and risks ending up as comic fodder in the annals of social media. We feel that it is our patriotic duty to provide a high quality vector format for both applications of the Coat of arms." Although the ARK has provided the accurate Coat of arms as seen in Figure 3 free in various versions for reproduction, mistakes and misrepresentations are common.



**Figure 4: The Kenya Government coat of arms**

This paper takes the view that the Kenya counties find themselves caught in this weak design foundation for the development of their Coats of arms and as a result most of them do not meet the good design threshold.

Coat of arms are designed and fashioned around heraldry principles of design that can be traced back to the 15th Century Europe. Heraldry, is a symbolic language used by institutions as an embodiment of their heritage, achievements and aspirations. Heraldry, "is a broad term, encompassing the design, display, and study of armorial bearings" (Wikipedia, Coat of arms). Armorial is an illustration of heraldic achievement, also referred to as the "Coat of arms" or symbol of sovereignty as more commonly used today. The design typically would feature "a shield, helmet and crest, together with any accompanying devices, such as supporters, badges, heraldic banners and mottoes" (Wikipedia, Coat of arms).

## Armorial Bearings

The armorial bearings on the Kenya Coat of arms include an African shield that has two sharp ends (top and bottom) accompanied by two crossing spears. It also borrowed heavily from tribal symbols by introducing a cockerel. The motto of the independent Kenya "*Harambee*" was introduced to symbolize the unity of purpose that was needed to develop the newly independent Kenya. The coat of arms, adhered to the heraldic principles and was duly registered. The Coat of arms may be used by Government ministries and agencies, statutory and non-statutory authorities, the parliament, law courts and tribunals. However, ARK agency notes that, few of these agencies pay attention to the identity symbol, and there is no provision to designers of tangible stuff to work with in the form of guidelines. As a result there is misuse and abuse of the instruments. The ARK gave an example of misspelling and slanted orientation of the Coat of arms. Visual elements and legal instruments of the country such as the map have been represented slanted in orientation by government agencies, in some instances the map is split (see Figure 5).



**Figure 5: Coast Water Services Board**

Consultation with specific agencies or stakeholders such as design institutions or professionals. This can be seen in the case of Gauteng province of South Africa. They contacted ten design agencies for expert input and advice before completion and

registration of their Coat of arms.



**Figure 6: National Irrigation Board logo**

The National Irrigation Board use a logo that depicts the country split into two with a water drop in the middle (see Figure 5). It is a depiction of the irrigation process. Although it has achieved a strong graphic representation, it also portrays an equally strong communication of a "divided" country (dysfunctional). Chapter 99 of the laws of Kenya articulates the use of national Flag, Emblems and Names Act. The act is silent or assuming on the image of the map of Kenya and boundaries. For this reason, logos like that of Coast Water that depict the country Kenya in this form may be contravening a law or if not, then there is a need for a law to prevent this form of visualization that misrepresents the country.

### **Design principles applied**

Graphic elements include the use of or combination of form, texture, layout, colour, symbols and lines. the resulting emblem or Coat of arms should exhibit design principles and these include aesthetics, harmony and balance. In the process, it is expected that the outcome will be communicating. To illustrate this point we can reference the Nike logo'

designed in 1971, by Carolyn Davidson, a graphic design student by then. It is a "simple" tick is full of meaning. In Greek mythology, Nike is the Winged Goddess of Victory. The mythology associations for the brand Nike are flight, victory and speed." (www.magneticstate.com). The second example is the Rio Olympic logo that was designed in 2016 by Tatil Design de Ideias and Dalton Maag focused on the people of Brazil, the host country, Gelli, the creative director said, "the logo was not designed for designers, but for everybody in the world, it represents Brazil's energy and how we receive people," (McCue, 2016). Gelli explained that the curves in the logo were from the mountains in Rio de Janeiro, the infitit design is iconic and has good meaning in all the cultures, and with an intended 3-D essence. On the colour, Gelli explained that Rio is a very colourful city and culture, the colours connected with their nature, green for the nearby forest (Tijuca Forest), blue for the ocean that inspires them, and yellow/orange from the warm temperature. The design explored 3-dimensional form in a 2-dimensional object and results in an animated logo that is "alive".



**Figure 7: The Rio 2016 Olympic logo created by Tatil Design**

Source: 99u.com

## **Abstraction**

Abstraction is used in design when manipulating images and obscuring realistic representation as a means of graphic communication. Abstraction typically starts with a 'known' realism and progresses into abstract representation. This popular art form can be traced to the Cubist period with famous artists such as Picasso. In the Nike logo in Figure 6, visual elements are reduced to basic non-representational non-realistic images through abstraction. The angle of the stroke, the thinning of the stroke and the thickness of the stroke converge to create the Nike logo. The known reality in the Rio logo of mountains, and ocean is abstracted into three 'simpler' forms floating in bliss. Distorted proportion is also closely associated with abstraction. An example of this is where, insects are illustrated as larger than human beings or human beings are made to be larger than buildings.

## **Aesthetics**

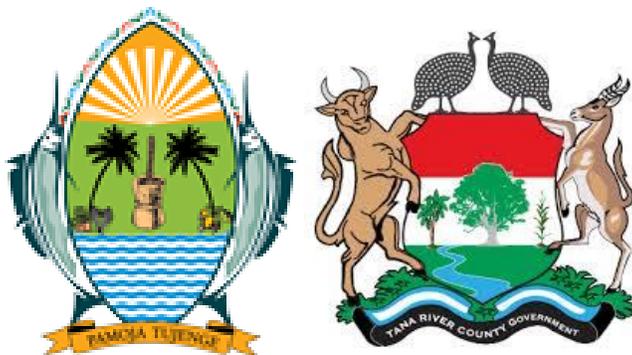
Aesthetics is important to design communication because it can define style and identity. It is diverse and each culture has rules and traditions that define the material, style, and scale of application. In application, one aesthetic may be considered different from another aesthetic by another person. This is because judgement and appeal is subjective and maybe influenced by exposure, culture and environments. However, several products, arts and environments have been able to achieve broad acceptance across cultures as aesthetic. It can also be said that increased exposure and cultural interaction has expanded the scope of acceptance of aesthetic. The more typical African aesthetic may refer to enchanting land and seascapes, environments, wilderness, green and floral kaleidoscope of colours, irregular and sinuous lines and sculpted forms for example, the clawed lion or bird feet on furniture. Community chiefs and leaders had their own sets of symbols understood by the clan and community. Heraldic inference between the western heraldry and African heraldry can be seen in Egyptian pharaohs such as King Tutankhamen (1341 BC - 1323 BC), fondly referred to as King Tut, whose artefacts influenced the Art Deco movement and continues to influence global design trends. The

young pharaoh wore a royal cobra headdress (URAEUS) and held a shepherd's crook and flail (symbols of royalty). These were symbols of supreme power in Egypt. On the golden adornment in which the mummified body of King Tut was found, were Egyptian hieroglyphic writings. The discovery of King Tut's tomb shed a lot of light on African symbolism.

Another graphic example of African symbolism can be seen in the Adinkra symbols of Ghana. Each of the symbols, origin, meaning, use and method of production or reproduction were embedded in the traditions of the Ashanti. The symbols have been broadly applied to jewellery, architecture, fashion, interiors and furniture.

### **The Coat of arms development by counties in Kenya**

For the development of county Coat of arms in Kenya, some counties opted to run competitions to identify appropriate emblems, others looked inwards to inherent local talent. Donna Pido, a design professional in Kenya, gives examples of Kilifi and Tana River counties Coat of arms as more successful (Pido, 2017). The two are fashioned around the European heraldic principles (see Figure 7).



**Figure 8 Kilifi county and Tana River county Coat of arms**

Some counties advertised for design proposals in the media. The advertisements however

did not provide enough guidance for effective design and development. Some advertisements excluded individuals and groups who may have made better contribution to the design. For example, Kakamega county advert specified that the designer must be a resident of Kakamega and they could only submit one design each. The advertisements sometimes restricted the designs to come from specific interest groups within the counties (such as youth) and they excluded some institutions such as universities and they did not provide enough guidance on the armorial bearings. It is also thought that many of the counties were rushed to develop the Coat of arms. In 2011 (a few months after the creation of the counties), the then Attorney general, urged the counties to urgently develop their Coats of arms as, "The use of Coat of Arms, especially in the disciplined forces and churches, serves as a sense of recognition, pride, belonging and an encouragement of a lifestyle based on honour and recognition of the responsibility and service to others," (Wako, 2011).



**Figure 9: Nandi County Coat of arms**

Nandi County referenced the National Coat of arms in their design. The armorial bearings are similar for example the symmetrical balance, shield and lion, except that one lion is replaced with a Nandi warrior. The Nandi warrior is historically significant in the history of the Nandi people. The other visual elements in the design are the milk gourd, cow and maize and tea that symbolize farming. Green is a dominant colour probably because farming is the major economic activity. The lion is rendered in two dimension while the

warrior has a more realistic rendering. The warrior is holding a shield that is barely visible and a spear. In a departure from the National Coat of arms design, the 'Nandi County' is clearly written in bold on a banner as the header in the emblem. At the base is 'Nandi gaa Kaburwo' which serves as the motto in the heraldic principles. The warrior is the weakest aspect of the emblem because of the grey colour and the detail that the designer tried to capture such as the facial expressions. The black outline on the bigger shield also 'over power' the thinner lines on the warrior in visual weight.

Many counties have depicted farming activities and livestock because, in general Kenya is an agricultural country. Other animals that have been depicted include camels, chickens, goats and sheep. Tea and coffee are found in some parts of the county and they are also depicted in their emblems.



**Figure 10: Trans Nzoia county Coat of arms**

Trans Nzoia county Coat of arms (Figure 9) has a visually symmetrical arrangement and can be said to have referenced heraldic principles. Two antelopes anchor the shield very much like the lions anchor the shield in the National Coat of arms. Within the shield, the armorial bearings that represent the economic activities of the county are placed. The Nandi county Coat of arms is a stronger and more calculated visual representation because they have kept fewer images or elements, a cow, "*mursik*" (sour milk), grain and an indigenous musical instrument. The choice and contrast in colours in the Trans Nzoia Coat of arms is more appealing than the Nandi Coat of arms colours that are very strong.

The Trans Nzoia county with the text reversed out of a soft tan colour, makes it less visually strong but more restful and stable and contemporary. When reduced further, the words may not be legible. Like the Nandi emblem, the name of the county is on the top banner and motto at the base. The Coat of arms is contained within a black border line.

West Pokot county have all the economic and livelihood activities represented in their Coat of arms. The *motto* is in the form of a pronounced word, "government" followed by a whole sentence, "Transforming lives through sustainable development." ideally, that sentence should not be part of the Coat of arms (See Figure 10).



**Figure 11: West Pokot coat of arms**

When you give design considerations for reducibility and legibility then the Coat of arms will lose clarity and become a blur. There is an acceptable level of clarity of elements or armorial bearings and the sentence cannot serve the purpose well in that regard.



### **Figure 12: Baringo County Coat of arms**

Baringo county armorial bearings include two revered animals namely the ostrich and rare kudu antelope anchoring a shield. At their feet is a Turkana stool/headrest and a milk gourd. It does not have too many elements or features, however, the proportions are disturbing (Figure 11). The ostrich and antelope are much larger than in proportion to the shield and the other elements. The representation of the ostrich and antelope are good, however the same cannot be said of the headrest and gourd that are placed against the green backdrop. The map of the county is placed in the middle of the shield. Unlike Nandi and Trans Nzoia, Baringo County Government is on the base banner, where the *motto* would have been.



### **Figure 13: Turkana county emblem**

The Turkana county emblem has taken the form of a work of art, depicting a man and woman, the 'cradle of mankind' imagery, mountain, camel among other things (Figure 12). Replacing the shield is a cloak that is typically worn by women. The motto at the base of the banner, 'pamoja tujijenge', is hand written. Unlike the other counties, Turkana county is not written on the emblem. So, whereas, detail is good, a graphic representation is more desirable for purpose of the emblem. The tip of the walking stick held by the woman is surprisingly close to the face a situation that could be sorted by graphic

representation. This also includes abstract representation and block colours that are easily distinguishable away from the grey scale drawing. The images in the middle section below the camel are too small and crowded thus they cannot serve their purpose well. At this stage of devolution, maybe it is important to have the name of the county as part of the emblem.

Machakos county, boasts an urban populace partly because of its closeness to Nairobi County that is the economic hub of the country. Much like the Turkana County emblem, "Machakos County" is not stated on the Coat of arms or emblem. It has an assortment of armorial bearings that includes a cow, ostrich feathers, Akamba traditional bows and arrows, a *moran* knife, a cow horn among other things (Figure 13). An attempt was made at maintaining symmetrical balance although the bearings appear too busy in their visual rendering. The *motto* banner is written in Kamba dialect, 'Kyaa kimwe kiyuaa ndaa.'



**Figure 14: Machakos county Coat of arms**

The text is not well executed, it looks handwritten. The border also is not well executed. The base of the Coat of arms has several technical flaws apart from the border line. The spear heads sticking out at the two ends do not fit well into the Coat of arms. The cow atop the shield is not appropriate. It would be expected that an animal such as the cow would have its feet on the ground. Pido commented that, "Machakos county has digitally distorted the image of a European shield, placed too many elements on it and has

manipulated images of what look like ostrich feathers in a way that makes them unrecognizable."

### **Design observation and recommendations**

From this brief presentation of county Coat of arms, it can be seen that several design observations can be made. The inspiration for the design in most of the Coat of arms is good because they draw from indigenous culture, environment and their individual diversity.

Most of the counties did not have *access* to the much needed design expertise that would have assisted in the arrangement of the armorial bearings, consideration of heraldic principles and design principles. It would have ensured the text is well rendered and arranged.

There is need for *consistency* in the basic design principles for the Coat of arms. This should include the inclusion or exclusion of the name of the counties within the Coat of arms. The placement of the name if considered needs to be defined so that the name of the county is not made to look like it is the *motto* or that the vision is part of the Coat of arms.

For purpose of *reduction and reproduction*, colours used within the Coat of arms need to be clean, clear and reproducible. Reference to Pantone colour range is necessary for reference and consistency in reproduction.

*Arrangement* of armorial bearings within the Coat of arms, needs professional design input before registration. This may involve manipulation and abstraction of elements so that the Coat of arms is aesthetic and in harmony.

The *advertisements* for the provision of design for Coats of arms were biased and did not favour some groups who may have made better contribution to the design. The

advertisements need to be better developed with the focus on the effectiveness of the Coat of arms.

The general *technical execution* of the Coats of arms is not acceptable. There are counties that have pictorial renderings of various features as their armorial bearings. Some of them have elevated paintings into armorial bearings. The typefaces and text used are not well executed.

Poor or inadequate *manipulation* of graphic elements resulted in the Coat of arms looking more like emblems and logos and thus not serving their purpose. The emblems are not ready to be escalated into heraldic symbols that can be registered as Coat of arms.

The *College of arms* and other relevant government institutions need to establish minimum standards for the development of Coat of arms and related visual elements before registration.

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## **Kiswahili na Maendeleo Mashambani Nchini Kenya**

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Idara ya Isimu na Lugha,

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### **IKISIRI**

Makala hii itatathmini umuhimu wa lugha (Kiswahili) katika kuchangia maendeleo nchini Kenya. Maendeleo yamejelezwa na wataalamu mbalimbali. Chambers (1997) ameeleza ‘maendeleo’ kwa usahili kabisa kuwa ni ‘mabadiliko mazuri’ (nchini au duniani). Alan Thomas (2000) ameyaeleza kama kuboreka kwa hali ya maisha, afya na maisha bora kwa wote na mafanikio ambayo huleta uzuri wa maisha kwa jamii yote. Haya hutokea kwa awamu ya muda mrefu. Maendeleo kwa jumla humaanisha mabadiliko chanya ya mwanadamu katika harakati zake zote za kimaisha. Maendeleo ni lazima kwa mwanadamu duniani. Hakuna wanadamu wanaobaki kama walivyo miaka nenda miaka rudi. Kuna maendeleo ya kibinafsi na ya kijamii. Yote haya huwezesha na kiwango cha uchumi. Uchumi hukua kutokana na uzalishaji mali. Uzalishaji mali hutokea katika mashamba na mitambo au viwanda. Uwezo huu huletwa na jamii kujifunza mbinu na stadi za uzalishaji mali. Mtu anapojifunza stadi fulani, lazima atumie lugha, lugha anayoielewa. Kwa hivyo, stadi haziletwi na Kiingereza bali lugha yoyote ile. Nchi nyingi ulimwenguni hazitumii Kiingereza na zimeendelea sana, mfano Ujarumani, Ufaransa, Italy, Malasyia, Korea Kisini na kadhalika. Kwa hivyo, natujiulize, je, hapa Kenya tunaweza kutumia Kiswahili kujifunza mbinu na stadi mbali mbali za kuzalisha mali? Hii ni kwa sababu Kiswahili ni somo la lazima nchini kutoka shule za msingi hadi shule za sekondari. Aidha ni lugha rasmi na ya taifa. Hivyo ni lingua franca nchini. Katika makala hii ninajaribu kudadisi swala hili na kutoa mifano kadhaa iliyopatikana nchini Kenya.

**Maneno makuu:** maendeleo, uchumi, mawasiliano, lugha, elimu

### **1.0 Utangulizi**

Maendeleo ni muhimu sana kwa nchi yoyote ile ili yamfaidi mwananchi. Maendeleo huathiri mwananchi kwa kiwango kikubwa na moja kwa moja. Nchi ikiwa na maendeleo duni, mwananchi hana budi kuwa na maisha duni pia, na nchi ikiwa na maendeleo bora, mwananchi naye atakuwa na maendeleo na maisha bora vile vile. Ili nchi kupiga hatua kimaendeleo, inahitaji sera za serikali kufahamika na kueleweka barabara na wananchi

wote nchini na kuungwa mkono. Mifano mizuri ni nchi za Asia ya Mbali; Korea Kusini, Malaysia, Indonesia, Thailand n.k na nchi za Ulaya. Hizi ni nchi ambazo zinatumia lugha zao asilia katika mawasiliano yao ya aina yoyote ile ikiwamo mafunzo shuleni na vyuoni. Hivyo, hapa Kenya, lugha ya kuelezea sera za serikali na mikakati ya maendeleo, lazima iwe lugha inayotumiwa na wote, wawe waliosoma au la. Lugha hiyo si nyingine ila Kiswahili, ambayo inatambuliwa kikatiba kama lugha rasmi na ya kitaifa (*Katiba ya Kenya*, 2010). Lakini natujiulize, je, Kiswahili kinatumika ipasavyo katika kueleza na kuendeleza sera za serikali hata wakaazi wa mashambani waelewe sera hizo? Vile vile kinatumika kuwafunza watu stadi na mbinu mbalimbali ili kuboresha uzalishaji mali? Haya ni masuala ambayo tutayadadisi katika makala hii na kuyafumbua. Nitatoa mifano kutoka hapa nchini Kenya na kwengineko ulimwenguni kudhihirisha kuwa lugha asili inapotumika katika mafundisho na usambazaji wa sera za serikali, maendeleo hupatikana.

## **1.2 Dhana ya Maendeleo**

Kabla ya kudadisi na kutathmini swala la Kiswahili na maendeleo, nitajaribu kufafanua maendeleo ni nini.

Maendeleo ni mchakato mseto wa kadri unaojumuisha upangaji mpya wa mifumo yote ya kiuchumi na kijamii. Lazima maendeleo yajumuishe mabadiliko ya miundo mbinu, msimamo, na asasi pia, kukua kwa uchumi, kupunguka kwa ukosefu wa usawa na kumaliza umasikini katika jamii (Todaro, 1992). Hivyo ni kwamba, maendeleo ya nchi nyingi si kuongezeka kwa mapato ya nchi tu.

Maendeleo inamaanisha si ukuaji wa uchumi tu lakini pia ni kuboresha hali ya maisha ya umma, kujumuika katika uchumi ambao ni tajiri kimuundo na kiteknolojia, na ujenzi wa uchumi ambao una muundo wa kudhibiti ukuaji na kuzidi kuwa bora (Murdoch, 1980).

Roodney (1989:29) anadai kwamba maendeleo katika jamii ni mchakato wenye mawanda mapana. Katika kiwango cha mtu binafsi, yanamaanisha kuwa na stadi na uwezo zaidi, uhuru zaidi, ubunifu, nidhamu, uwajibikaji na uwezo wa kuwa na bidhaa tofauti tofauti. Tunaporejelea maelezo haya, mtu anatakikana kuwa na stadi zaidi zinazozaa uwezo wa

kiuchumi. Stadi hizi mtu hufunzwa kwa lugha anayoelewa. Kwa hivyo hapa Kenya tukihitaji watu wawe na stadi zaidi, basi wawe watajifunza kwa Kiswahili ili wengi wafaidi. Hii ni kwa sababu, Kiingereza hakifahamiki na watu wengi kama Kiswahili. Tunapofanya hivyo, tunamuwezesha mtu binafsi na kutumia stadi hizi kwa maendeleo yake binafsi na nchi kwa jumla. Maendeleo ya kiuchumi huletwa na uzalishaji mali bora na nyingi. Hili hufikiwa katika nchi iwapo wafanyikazi watakuwa na stadi bora zinazoweza kuzalisha bidhaa bora. Stadi hizi hupatikana kupitia mafunzo shuleni au viwandani.

Kwa hivyo 'maendeleo' ni dhana pana ambayo inajumuisha maisha yote ya mwanadamu na kwamba lengo liwe kuyaboresha. Kama wadaivyo Todaro (1992) na Desai (1982), nchi itakuwa haijaendelea ikiwa kiwango cha uchumi kitakuwa kimekua kwa asilimia maridhawa lakini wengi nchini bado ni masikini na wanakosa miundo mbinu ya kimsingi. Yaani, bado wengi hawana kazi, wafanyikazi hawana stadi, wananchi hawapati huduma bora za matibabu, hawana umeme, hawana maji safi n.k. Hivyo, jukumu la serikali yoyote ile ni kuleta maendeleo nchini, na lazima miundo mbinu hii itiliwe maanani na serikali ijaribu kupiga vita umaskini, ukosefu wa kazi, magonjwa n.k. Hii itafanya umma wote uendelee kwa jumla. Iwapo utajiri utakuwa chini ya watu wachache nchini, basi nchi itazidi kukosa maendeleo na kubaki maskini.

Katika makala hii ninachukulia dhana "maendeleo" kama ilivyoelezwa hapo juu na Todaro, Desai na Roodney. Ili kuwa na maendeleo nchini, kuna mambo kadhaa ambayo lazima yatimizwe:

- i) Lazima habari zisambazwe kwa umma juu ya sera na mikakati ya serikali, na kutoa ushauri kwa umma jinsi ya kujiendeleza.
- ii) Lazima udundulizaji na utunzaji wa rasilimali, elimu na mafunzo yafanyike ili umma umudu kuendelea na kutumia stadi zao, uwezo na tafakuri.
- iii) Ni kuwepo kwa asasi faafu za kijamii, kiuchumi na kisiasa ambazo zinawezesha na kuruhusu ukuaji wa stadi hizo za uwezo wa kuongeza uzalishaji mali (Murdoch, 1980:170-171).

La msingi hapa ni umma ufahamishwe, upate stadi na kuwa huru kuweza kutumia uwezo wake kuzalisha mali zaidi. Mambo haya yatafikiwa kwa kuhamasisha na kufunza umma stadi mbalimbali katika uzalishaji mali. Yote hawa hutimizwa kwa kupitia mawasiliano. Mawasiliano hutimia kwa mpewa ujumbe anapoelewa ujumbe huo kutoka kwa mtuma ujumbe. Katika mawasiliano lazima lugha itumike, inayofahamika kwa pande zote mbili, mtuma na mpokeaji ujumbe (Mbithi, 1974). Hapa nchini Kenya mawasiliano kama haya yanawezekana kwa kupitia lugha ya Kiswahili kwani ndiyo lugha inayofahamika kwa wengi kuliko lugha yoyote ile. Kiswahili ni *lingua franca* Afrika Mashariki kote (Chimera, 1998). Kiswahili ni lugha ya Taifa na rasmi nchini Kenya (Katiba ya Kenya, 2010).

Watu wengi nchini Kenya wanaishi mashambani na lugha ifahamikayo zaidi kando na lugha ya kwanza ni Kiswahili. Kupitia Kiswahili, mawasiliano yatawafikia watu wengi zaidi nchini Kenya. Mashambani, kazi muhimu ni ukulima na mijini ni viwanda. Huko mashambani, ili wananchi wamudu kukuza chakula zaidi, wanahitaji mbinu mpya za kisayansi. Mbinu hizi zimo vitabuni kwa lugha za kigeni mfano Kiingereza hapa nchini Kenya. Lugha hii ni ya watu wachache. Kwa hivyo, kuelewa mbinu hizi vyema, lazima mafunzo yawe kwa Kiswahili, lugha wanayoifahamu vyema wakulima. Au lugha za kwanza, iwapo mtaalamu anafahamu lugha ya kwanza ya wakulima. Maofisa wa Kilimo wanatoka katika jamii mbalimbali, na kufanya kazi katika Kaunti mbali na zao na lugha ya kwanza ni tofauti na zao (si wakati wote). Kwa hivyo chaguo ni lugha ya Kiswahili kwa mawasiliano.

Murdoch (1980), Desai (1982), Miller (1988), Todaro (1992), wote wanakubaliana kuwa ukulima ndio umechangia pakubwa katika nchi nyingi ulimwenguni kuleta maendeleo ya kiuchumi. Umuhimu wa ukulima ni ule mchango wake katika kuinua hali ya maisha kifedha. Kwa hivyo, mchango wa kwanza kabisa wa kilimo ni kuinua hali ya maisha ya umma mashambani (Murdoch, 1980:172). Murdoch anaendelea kudai kuwa uchumi bora wa nchi kama vile Ulaya, Marekani na Japani katika karne za 18, 19 na 20 ulichangiwa pakubwa na kilimo (Kama hapo juu:183).

Mnamo 1880, wakulima huko Japan walionyesha uwezo wao kwa kukubali mbinu mpya za ukulima, na wale waliopata ujuzi zaidi mashambani, walitumiwa kama walimu kufundisha wenzao katika vyuo vya kilimo na pia kuwa washauri nyanjani kwa kutumia Kijapani. (Kama hapo juu:187). Huko India, Taiwan, Korea Kusini, mambo yalikuwa vivyo hivyo (Desai, 1982; Todaro, 1992). Lugha za mawasiliano zilikuwa lugha zao asili au za kwanza. Je, kwa nini nchini Kenya jambo hili lisifanyike na lugha ipo ya Kiswahili ambayo ni *lingua franca* nchini?

### **1.3Uwezekano wa Kiswahili kutumika kufundishia Umma Maswala ya Maendeleo**

Tangu Tume ya MacKay (1984) juu ya Chuo Kikuu cha Pili hapa Kenya kupitisha Kiswahili kuwa somo la kutahiniwa katika shule za msingi na sekondari, watu wengi sana hapa Kenya wamesoma Kiswahili na kuifahamu lugha hiyo. Sasa ni miaka takribani thalathini na tatu (33) kwa Kiswahili kuwa somo la lazima nchini Kenya. Kwa hivyo, wazungumzaji ni wengi sana nchini na Kiswahili kinafahamika katika pembe zote za nchi. Jitihada ni zifanywe kukitumia kufundishia watu mashambani stadi mbalimbali kama vile za ukulima, uashi, useremala, uhunzi n.k. Jambo hili likifanyika, Wakenya watakata ujuzi wa kiufundi na wa kilimo. Hili litasaidia kuzalisha mali zaidi na bora, ambazo zitauzwa nchini na hata nchi za nje kupata fedha za kigeni na kuendeleza uchumi wa Kenya.

Wataalamu wa mitalaa wanafaa wakumbatie wazo hili na kugeuza njia ya kufundishia hususan masomo ya kiufundi. Istilahi zitajitokeza tu. Hoja hii inashadidiwa na Fromkin, Rodman na Hymns (2007:88-89) wanaposema kuwa kunapotokea pengo la kileksia (*lexical gap*), wazungumzaji watazua istilahi za kujaza pengo hilo na zitatumika katika mawasiliano ingawaje si sanifu, na huenda zisiwepo katika makamusi wakati huo. Vile vile wakatoa mifano ya jinsi Kiingereza kilivyozua maneno mapya kujaza pengo hilo; *unsystem, uglification, Chomskykan, breathable, chopoffable* n.k. Na maneno haya yanatumika katika mawasiliano ingawaje si sanifu. Hatuwezi kupata istilahi bila kuanza sera hii. Ikumbukwe safari ni hatua. Kwa mfano, kwa mujibu wa Rashid (1992: 194-195), lugha ya Dari (Persian) huko Afaghanistan, imezaa istilahi za kiufundi, mifano:

*enjiniri* (engineering), *motirsikel* (motorcycle), *partaim* (part-time). Wenzetu hawa wanatumia lugha ya Dari katika kufundisha uhandisi Chuo Kikuu. Hivyo hapa Kenya, jambo hili linawezekana kwa kutumia Kiswahili. Kwa mfano, ugonjwa wa HIV/AIDS ulipoingia Afrika Mashariki, istilahi zilipatikana kwa dhana zinazohusishwa na ugonjwa huu, mfano *UKIMWI* (HIV/AIDS), *unyanyapaa* (stigma), *virusi* (virus), n.k. Kwa sasa hivi istilahi nyingi zimezaliwa kusimamia dhana mbalimbali, mfano *nywinywila* (password), *tarakilishi* (computer), *kipakatalishi* au *kiuweo* (laptop), *uwajibikaji* (accountability), *uwazi* (transparent) n.k. La msingi ni Kiswahili kitumike katika kueneza sera za serikali na kutoa stadi kwa vijana ili kuzalisha mali na kuchipua maendeleo mashambani. Wazungumzaji wa Kiswahili watazalisha istilahi kukamilisha mawasiliano yao.

Tuangalie mifano michache ifuatayo kutokana na utafiti huu juu ya Kiswahili kutumika mashambani na katika viwanda vya Jua Kali vya ufundi.

### **1.3.1 Mifano Nchini Kenya**

Tatizo kubwa nchini Kenya ni kupuuza Kiswahili katika maswala muhimu ya nchi. Tutakapozingatia kwa dhati mawasiliano yetu kwa lugha ya Kiswahili, istilahi zitapatikana. Mfano mzuri wa kutumia Kiswahili mashambani katika miradi ya kiuchumi ni huko tarafa ya Njoro katika Kaunti ya Nakuru. Rono (2001:137) anaeleza kuwa wakulima wanawake kwa wanaume waliopata elimu kwa kupitia lugha za Kiswahili na Kiingereza, waliweza kuongeza uzalishaji mali maradufu kwa sababu ya mawasiliano bora katika mawazo na uvumbuzi wa mbinu mpya za ukulima. Mawasiliano haya yalikuwa mwafaka kwa sababu Kiswahili kilitumika pamoja na Kiingereza kati ya wakulima hao na wataalamu nyanjani. Wanapozalisha mali zaidi biashara nayo hupanuka, wapate fedha zaidi na kuongeza maendeleo.

#### **1.3.1.1 Kaunti ya Kwale**

Huko Kaunti ya Kwale, tarafa ya Matuga, Lokeseni ya Golini, kikundi cha akina mama cha 'Jitahidi' cha ufugaji ng'ombe wa maziwa, niliwahoji kuhusu utaalumu wanaoutumi wa kudunga ng'ombe sindano, kupuliza dawa za kupe waliupata wapi. Walinielezea kuwa

walifundishwa na Ofisa wa Wanyama wa nyanjani kwa lugha ya Kiswahili. Akina mama hawa hawajui kusoma wala kuandika na wanadunga ng'ombe wao sindano wanapokuwa wagonjwa au kuzuwia magonjwa. Kiingereza hakikutumika hapo, na shughuli za ufugaji zinaenda vyema. Wanapata maziwa na kuuza. Mweka hazina wao aliniarifu kuwa hupata takriban shilingi elfu kumi na mbili kwa mwezi kutoka ng'ombe wao wawili.

Katika eneo hilo hilo, mfugaji mwingine wa ng'ombe za kienyeji, Mzee Salimu Mohamed Madindima mwenye umri wa miaka sabini hivi (70), hajui kusoma wala kuandika lakini huwatibu ng'ombe wake kwa kuwapa dawa na kuwadunga anapogundua ni wagonjwa. Mtafiti alishuhudia kitendo hiki (Agosti 25, 2014) alipomtembelea nyumbani kwake. Alipomuhoji anawezaje kutimiza huduma hii na hajui kusoma. Alinifahamisha alifunzwa haya yote na Daktari wa Mifugo wa nyanjani. Alifunzwa dalili za magonjwa mbalimbali na dawa za kutibu magonjwa hayo. Alifundishwa vipimo mbalimbali vya matumizi ya dawa za kutibu mifugo. Huwadunga ng'ombe wake na kuwatibu. Nilipomuuliza alifundishwa kwa lugha gani, alinieleza Daktari alitumia Kiswahili. Kwa sasa hivi hahitaji daktari. Yeye mwenyewe huenda duka la madawa akanunua dawa na kuwatibu ng'ombe wake.

### **1.3.1.2 Kaunti ya Uasin Gishu**

Katika Kaunti ya Uasin Gishu, mtafiti alizuru kiwanda kimoja cha jua kali mjini Eldoret. Hapo alimkuta fundi wa kutengeneza mitambo ya kusaga mahindi inayotumia umeme, Bw. Allan Onyango (umri wa miaka 45) na wanafunzi wake. Nilimuhoji kiwango chake cha masomo, akaniambia ni darasa la saba. Nikamuuliza jinsi alivyopata ujuzi huo. Akaniarifu alijifunza katika kiwanda cha jua kali huko Kaunti ya Kisumu. Akaniarifu alifundishwa kwa kutumia Kiswahili, na majina ya vifaa alivyovitumia mwalimu wake alivitaja kwa majina ya Kingereza wakati wa mafunzo. Na kwa sasa hivi hutengeneza mitambo minne kwa wiki akiwa na wanafunzi wake. Wanojifunza hapo kwake, huwafunza kwa lugha ya Kiswahili. Kuna majina kama *motor*, *grinder*, *swicth*, msumeno wa umeme, vyuma n.k hutumia matamshi ya Kiswahili kwa kuvirejelea vifaa hivyo.

Vile vile mtafiti alizuru gereji ya Jua Kali katika eneo la Asis Hoteli mjini Eldoret na

kuwahoji mafundi wa magari wakiwemo wanafunzi katika gereji hizo. Alisikia Kiswahili kikitumika katika harakati zote. Vifaa mbalimbali viliitwa majina yao ya Kiingereza lakini kwa matamshi ya Kiswahili mfano *ekzosti, tairi, handibreki, jeki, nati, indiketa* n.k. Baadhi ya vifaa vilipewa majina ya Kiswahili mfano '*strainer*' katika *oil sump* walikiita '*kichungi cha sampu*', '*filter*' walitumia neno '*kichungi*'. Na kazi iliendelea vyema magari yakitengenezwa bila kikwazo cha mawasiliano.

Kutokana na mifano hii, ni dhahiri kwamba Kiswahili kinaweza kutumika mashambani kuelimisha na kufunza stadi mbalimbali ili kuchangia maendeleo ya mtu binafsi, umma na nchi kwa jumla. Istilahi mbalimbali zitapatikana pindi tutakapoanza kukitumia Kiswahili kama njia ya kufundishia shuleni na vyuoni. Kuna njia mbalimbali za uzalishaji wa msamiati. Njia hizi zikitumika, msamiati utazalishwa kupitia utaalamu huu wa leksigrofia.

### **1.3.1.3 Kaunti ya Machakos**

Mtaa wa Grogan, Mchakos ni eneo la viwanda vya Jua Kali. Ingawaje viwanda hivi ni ithibati ya kutoendelea, lakini serikali ikisaidia mafundi hawa, kutazaliwa eneo la viwanda vya hali ya juu. Nchi za Korea Kusini na Uchina zilianza kuwa nchi za viwanda kama zijulikanazo leo, kwa kupitia viwanda vya Jua Kali. Serikali za nchi hizi ziliwekeza katika viwanda hivi na mafundi kupewa mafunzo ya hali ya juu kwa kutumia lugha zao asili. Mtaa huu wa Grogan una mafundi wengi; wa magari, wa viti vya magari, ucholemeaji, wahunzi, seremala n.k. Mtafiti alizuru eneo hili na kuteuwa kimakusudi mafundi wawili; mmoja wa umeme wa magari (*motor wiring*) na mmoja wa ucholemeaji (*welding*). Fundi wa umeme wa magari anaitwa Bw. Stephen Mumo mwenye umri wa miaka arubaini na tano (45) mzaliwa wa Mtituni, Machakos. Alinielezea kuwa alisoma hadi darasa la nane (STD. 8). Hakuendelea kwa upungufu wa pesa kwani baba yake alikuwa masikini. Akajiunga na mafundi wa Jua Kali hapa Grogan. Sasa hivi ndiye fundi msika katika eneo hili kama fundi wa umeme wa gari. (Ameshawahi kurekebisha gari la Mtafiti huyu.)

Nilipomuhoji alijifunza ufundi huo kwa lugha gani, alijibu kwamba alijifunza kwa Kikamba na Kiswahili. Kiingereza kilitumika kutaja vifaa au vipuri vya magari vya

umeme mfano *alternator; distributor; socket* n.k. Alijivunia ujuzi wake na akanieleza kwamba hata wanafunzi wa Diploma walio waandamizi nyanjani (*attachment*) huwafundisha ilhali hana cheti chochote cha kusomea ufundi huo.

Fundi wa pili ni Bw. Safari Mbithi mwenye umri wa miaka hamsini na tatu (53), mzawa wa milimani, Machakos. Alisoma hadi darasa la nne (STD 4). Akaacha shule akajiunga na mafundi wa Grogan kujifunza uhomeaji. Lugha alizozitumia kujifunza, aliniarifu ni Kikamba na Kiswahili. (Alimchomea Mtafiti huyu bomba la kutoa moshi (*exhaust pipe*) la gari yake mwaka wa 2016 hadi leo 2018, halijaleta matatizo.) Mtafiti alimfumanika akitengeneza jiko la kuoka keki wakati wa utafiti huu. Jiko hilo alilikamilisha na akadai ni agizo la mwokaji na ameshatengeneza mengi yanayotumika hapa mjini Machakos.

Mifano hii miwili, ni dhihirisho kwamba lugha yoyote inaweza kutumika katika kufundishia ujuzi wowote. Kwa hivyo Kiswahili kama *lingua franca*, lugha rasmi na lugha ya taifa hapa Kenya (Chimera, 1998; Katiba ya Kenya 2010) kinaweza kutumika, kufundishia ujuzi mbalimbali na kuwawezesha vijana kuzalisha mali na kujijari ili kuleta maendeleo hapa nchini Kenya. Ufundi hauhitaji Kiingereza bali lugha yoyote ile inayoeleweka na kuwasilisha ujumbe katika jamii.

#### **1.4 Njia za Kuzalisha Msamiati katika Lugha**

Wanaleksigrofia hutumia njia kadhaa kuzalisha msamiati katika lugha, hususan kwa dhana mpya zinazozuka kila uchao. Njia hizi hupendekeza jinsi wataalamu wanavyoweza kuunda msamiati mpya na kukidhidhi mawasiliano na kuziba pengo la kileksia. Njia hizi ni zifuatazo.

##### **1.4.1 Unyambuaji**

Unyambuaji ni njia mojawapo ya kuzalisha maneno katika lugha (O'Grady na wenzake, 1996; Fromkin na wenzake, 2007; Bauer, 1983). Hii ni njia ya kunyambua neno ili kuzaa neno lingine kusimamia dhana mpya au kuzaa neno jipya. Kwa mfano katika Kiswahili, neno *boresha* lilizaliwa kwa kunyambua kivumishi *bora, bidhaisha* (commoditization) kutoka nomino *bidhaa, rembesha* kutoka nomino *mrembo* n.k. Kwa hivyo Kiswahili

kinaweza kutumia njia hii kuzalisha msamiati mpya kusimamia dhana mpya mbalimbali.

#### **1.4.2 Uzalishaji**

Uzalishaji wa maneno huletwa na uambishaji. Uambishaji ni kuongeza viambishi katika neno hususan kabla mzizi. Hii ni njia ya kimofolojia katika lugha. Mfano katika Kiingereza maneno kama, *undo, unearth, untread, unfit, ungodly, unhealthy, unhappy* n.k. yalitokana na kuweka kiambishi kabla ya mzizi wa neno (Fromkin na wenzake, 2007:89-91). Kwa hivyo katika kutafuta msamiati mpya katika Kiswahili, njia kama hii inaweza kusaidia kuzaa msamiati mpya.

#### **1.4.3 Uambatishaji**

Hii ni hali ya vipashio huru viwili au zaidi kukaa pamoja ili kuunda dhana moja mpya. (*Kamusi Sanifu ya Isimu na Lugha*, 1990:14) Njia hii hutumika katika Kiingereza na kuzaa msamiati mpya (O'Grady na wenzake, 1996:151; Yule, 1997:65). Katika Kiswahili njia hii ilitumika kuunda maneno kusimimamia dhana mpya mfano *askarigongo, mwanaharamu, mwanajeshi, mwanahewa* n.k. Kwa hivyo njia hii inaweza vile vile kutumika.

#### **1.4.4 Uundaji**

Hii ni njia ya kuunda neno tu ama kwa kukopa au neno lililopo kusimamia dhana mpya. Kiingereza kilizaa maneno kutoka lugha nyingine au yaliyopo, mfano maneno *cepstrum* na *cepstral* kutoka maneno yaliyopo *spectrum* na *spectral* (Fromkin na wenzake, 2007:92-93). Yule (1997:64) akatoa mifano ya maneno yaliyoundwa katika Kiingereza; *nylon, zipper* na *xerox*. Katika Kiswahili kwa mfano, maneno *unyanyapaa (stigma), tarakilishi (computer), runinga (television), tovuti (internet)* ni maneno yaliyoundwa na wataalamu wa Kiswahili mfano Sheikh Nabahan na Rocha Chimera kusimamia dhana mbalimbali. King'ei katika Ogechi na wenzake, (2008:223) ameonyesha baadhi ya maneno ya Kiswahili kutokana na uundaji; *nywila (password), kiranja (prefect), karabati (repair)*.

#### **1.4.5 Ujenzi ghairi**

Ni uundaji wa neno ambao huenda kinyume na utaratibu wa kawaida (*Kamusi Sanifu ya Isimu na Lugha*, 1990:8). Fromkin na wenzake (2007:94) wanadai ni uundaji wa neno kutokana na kutojua mofolojia ya lugha. Hutokana na kutoelewa utaratibu fulani wa mofolojia ya lugha, hivyo watu kuunda neno na likakubalika. Wakatoa mfano wa maneno *stoke*, *swindle*, *peddle* kuwa yalitokana na watu kudhani kuwa kiambishi *-er* katika maneno husimamia mtenda, hivyo kitendo ni kutoa kiambishi hicho.

#### **1.4.6 Akronimi**

Ufupishaji huzaa akronimi. Haya ni maneno yanayotokana na ufupishaji wa maneno yaani kuchukua herufi moja moja katika kila neno na kuunda neno jipya (Fromkin na wenzake, 2007:98), mfano U.S.A (United States of America), A.U (Africa Union) n.k. Katika Kiswahili neno *Ukimwi* ni akronimu inayotokana na ‘*Ukosefu wa kinga mwilini*’n.k.

#### **1.4.7 Uhulutishaji**

Ni uundaji wa maneno ambapo sehemu za maneno mawili huunganishwa, na sehemu nyingine kudondoshwa na kuunda neno moja (Fromkin na wenzake, 2007:97). Fromkin na wenzake wakatoa mifano ya Kiingereza, maneno; *smog* (smoke + fog), *urinalysis* (urine + analysis) n.k. Katika Kiswahili kuna maneno *chajio* (chakula cha jioni), *chamcha* (chakula cha mchana) (*Kamusi Sanifu ya Isimu na Lugha*, 199:9).

#### **1.4.8 Ukopaji**

Ni njia ya kupata msamiati kwa kuhamisha kipashio kutoka lugha moja na kuingizwa katika lugha nyingine (*Kamusi Sanifu ya Isimu na Lugha*, 1990:9). Mbinu hii imetumika katika kuzalisha msamiati wa Kiswahili mfano *motokaa* (motorcar), *shokomzoba* (shock absorber), *hela* (hela-Kijarumani), *hospitali* (hospital), *shukurani* (shukran-Kiarabu), *pesa* (paise-Kihindi) n.k.

#### **1.4.9 Ukatizaji**

Ni mbinu ambapo neno hupunguzwa silabi na kuwa neno moja (Yule, 1997:66). Mfano katika Kiingereza ni *flu* kutokana na influenza, *phone* kutokana na telephone,

*brakutokana* na *brassiere*. Katika Kiswahili, sijapata maneno yaliyoundwa kutokana na mbinu hii lakini yanapatikana katika sheng mfano *hosi* kutokana na hospitali, *moti* kutokana na motokaa, *konda* kutokana na kondakta n.k.

Hizi ni mbinu ambazo wataalamu wa Kiswahili wanaweza kuzitumia kuzaa msamiati wa Kiswahili kusimamia dhana au vyombo mbalimbali. Kwa hivyo swala la ukosefu wa msamiati halina mashiko. Lililobaki ni juhudi, ari na jitihada kwa wazungumzaji wa Kiswahili.

### **1.5 Hitimisho**

Ni dhahiri kuwa maendeleo ni zaidi ya pato la nchi kuongezeka (*Domestic Gross Product*). Pia ni bayana mashambani kunachangia maendeleo ya nchi kwa uzalishaji maji na si kilimo tu. Maendeleo lazima yalete mabadiliko katika maisha ya umma nchini, na mabadiliko yenyewe yawe chanya. Kinyume na hivi, nchi bado haijaendelea hata kama asilimia ya uchumi wa nchi inakua. Jambo hili lilitokea huko India, Pakistan, Taiwan, na baada ya nchi hizi kugundua hali hiyo, ikabidi mikakati ya kiuchumi ibadilishwe ili maendeleo yapatikane katika nchi. Watu wa mashambani walihusishwa zaidi na kufunzwa stadi mbalimbali kwa kutumia lugha zao wanazozitumia (Todaro, 1992, Desai, 1982, Miller, 1988).

Kwa hivyo, ili malengo haya ya maendeleo yawafikie wengi nchini kote hapa Kenya, lazima umma mashambani ujumuishwe kwa kuyajua malengo yenyewe na kupata stadi mbalimbali (**Mfano malengo ya sasa, 2018 ya Rais Uhuru Kenyatta- The Agenda Four**). Haya yatawezekana kwa kutumia lugha inayotumika kwa wote minghairi ya kiwango cha elimu walichonacho. Lugha iliyofikia kiwango hiki hapa Kenya ni Kiswahili. Tumeona jinsi Kiswahili kinatumika huko mashambani katika Kaunti za Kwale, Uasin Gishu na Machakos katika uzalishaji mali. Wengi wameeleza na kuisitiza jambo hili hapa nchini Kenya wakiwemo Mwita (2001), Shitemi (2001), Chimeara (1998), na wengine. Lakini hadi leo, serikali haijatilika maanani mawazo na mapendekezo haya. Hata hivyo, Profesa Anyang' Nyong' alipokuwa Waziri wa Uchumi na Mipango, alitoa mwongozo wa "*Mikakati Ya Kufufua Uchumi ili kuzalisha Mali na Ajira nchini*

*Kenya 2003-2007*" mwaka wa 2003, chini ya serikali ya NARC ikiongozwa na Rais Mstaafu Mh. Mwai Kibaki. Hii ni hatua mwafaka kwani lugha zote mbili za Kitaifa zilitumika Kiingereza na Kiswahili. Na katika mwaka wa 2010 *Katiba Mpya ya Kenya* iliandikwa kwa lugha zote mbili rasmi, Kiswahili na Kingereza. Jambo hili lilifanya umma kufahamu haki zao zaidi na sera za serikali katika ugavi wa mali mashinani chini ya mfumo wa ugatuzi. King'ei (2008) ametoa mifano ya istilahi za Kiswahili katika teknolojia ya Habari na Mawasiliano ambazo ziliuundwa au kokopwa na zinatumiwa. Hili ni dhihirisho kuwa tunapoanza jambo, basi istilahi zitapatikana kwa sababu ya hiyo haja. Ikumbukwe, "*necessity is the mother of invention*".

Kwa hivyo, ili maendeleo yapatikane mashambani, lugha ya Kiswahili izidi kutumika kusambaza sera za serikali na kufunza jamii za mashambani stadi mbalimbali, mfano mbinu bora za kilimo na ufugaji, uhunzi, uashi n.k. Hii itasaidia uzalishaji mali zaidi na matokeo ni maendeleo ya jumla kuchipuka. Aidha maisha ya jamii kuwa bora zaidi.

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# **Sustainable Design Approaches for Handicraft Community Development in Machakos County.**

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## **ABSTRACT**

This paper highlights the important role played by design in shaping the new African continent economically, socially and environmentally. This role is highly linked to the rich interaction between religion, art and culture in Africa. Africa thrives well through networks formed by different cultures, customs, history and people spirit of working together. It is in such setups that handicrafts communities thrive well, however, Africa has been left behind in the sustainability of the practice key to rural development. This paper is aimed at exploring ways in which design can play a key role in the process of developing sustainable handicraft communities from inception to full implementation. It also explores the barriers for the uptake of community development initiatives in the design profession in Africa. Qualitative analysis and case studies are the major research strategies used. Wamunyu area will be used as the case study of a handicraft community existing in Machakos County. Data collected from archives, interviews and published reports for this purpose. This paper concludes that design plays an important role in the development of sustainable handicraft communities especially in the rural areas. The impact of this research is realized by the benefits of sustaining the handicraft communities that are important enterprises in rural areas development. The innovative use of design approaches today ensures a smooth transition for design use in Africa's problems tomorrow.

**Key words;** Community development, Design approaches, Handicrafts, Sustainability.

## **INTRODUCTION**

Africa thrives well through networks formed by different cultures, customs, history,

practices and people's spirit of working together. It is in such setups that development activities thrive well however they are practiced at an informal or traditional level thus not well developed to full potential in rural areas. Rural development has been a key subject dating back to the industrial growth in urban centers of the 1970s to date. Rural areas according to Limkriengkrai (2010) are key support of any development as they provide raw materials and skilled labor to the growing economy in urban areas though do survive alone by small economic activities apart from farming. The informal sector plays a key role in rural development especially in ecologically fragile areas. Small scale industries forming important occupational activities and source of income to the majority of the people. Rural areas open opportunities for the growth of handicrafts due to the availability of skills and raw materials. Mutinda (2014) points out that these activities can be grown from a traditional craft to a successful commercial industrial operation if well-organized with proper marketing channels, access to institutional credits and environmental preservation methods. This is in line with the Kenya's Vision 2030 development blue print aiming at making the country a newly industrialized middle income nation providing high quality of life for all its citizens. The vision's pillars targeting to encourage development through investing in people with provision of equitable social development in a clean and secure environment aimed at issue based, people centered and results oriented policy approach. The foundations of the blue print contributing to the development agenda through wealth creation opportunities, infrastructure, innovations and developing human resources to be globally competitive through training and education (Kenya Vision 2030).

The nature and extent of these rural communities are short lived in the country as they do not meet and maintain basic elements of sustainability such as proper planning processes, public participation, infrastructure and opportunities. Unwto (2005) attributes these development setbacks to the view of rural development as with less economic opportunities. Previous research and case studies in South Africa, asia and south america indicates that the continuation of these communities can be achieved through product service approaches enshrined in community based and sustainable community tools (unwto, 2005). Sustainable community tools include integrated design processes (idp), post development monitoring and community dialogues allowing opportunities, innovation and continuity. the suggested approaches are custom to each community as observed by richards (2013).

the commonly used approach in africa for handicraft community development is the community based tourism working around the product as the center with an aim of adoption as a business model as practiced in edo state nigeria, zambia, uganda and in some parts of kenya. This model however faces environmental degradation problems and reduced participation by stakeholders thus maturity of the community is not achieved and points out the need for review. Reduced natural resources due to over exploitation also discourage the activity. competition, middlemen who profit from the business more than the community, poor marketing channels and lack of proper organization and implementation processes are other challenges cited (unwto, 2005; mutinda, 2014). One such handicraft community is the wamunyu wood carvers of the akamba people in Machakos County.

The wamunyu handicraft community is home to an estimated 8,000 people practicing wood carving, drums making, beadwork and weaving dating back since the introduction of carving in 1918 by mutisya munge. The community has seen the establishment of other smaller communities of wood carvers and other handicrafts in kitui, makueni, malindi, Mombasa, nanyuki and nairobi. Artists apprentice others for continuity relying on tourists and the machakos cooperative union for marketing and funding. Being a practice highly dependent on natural resources such as trees, the community has initiated a program for planting and selling trees for sustainability of the practice. Other initiatives are by the county government to promote the area as a cultural center, online marketing, value addition and proposition as a world heritage site. At the center, not many people are involved in the handicraft making due to low markets of products, low prices for the products, limited funds and limited resources thus the need for examination of the activity and improvement of the current community organization processes and structures for a more sustainable community based approach.

## **RURAL DEVELOPMENT**

The term development has regularly been towards the idea of good change established to exist when the wellbeing and quality of life is improved (Chambers, 1995). Rural development referred to as meaningful growth economically, culturally and environmentally in the country side or non-urban settings.

Development In Rural Settings Are Originally Conceptualized As Avenues For Economic Opportunities For Undeveloped Localities Targeting Groups Rationally Described As Remote, Rural, Impoverished, Marginalized, Economically Depressed, Poor, Indigenous, Ethnic Minority And People In Small Towns (Muganda, 2009). They Are Characterized By A Traditional, Participatory Or Agricultural Economic System In Which Work, Goods And Services Utilize Resources Established In Long Traditional Patterns (Ndlovu, 2015).

Rural Development Progress Well When People Work Together Towards Similar Goals. People Act Independently In Their Own Interest Thus Unintentionally Deplete Resources Contributing To The Consumption Of Resources On A Basis Of Continuous Habits Thus The Need For Unity Of Purpose Fulfilled In A Rural Community Setups (Turcu, 2012). Community Participation Is Also Key For Development Of Rural Areas From Inception To Fulfillment Through Power Redistribution, Citizen Participation, Collaboration Processes And Social Capital Creation Equitably Distributed.

The Availability Or Existence Of Communities' Setups In Rural Areas Greatly Influences The Destination Of Choice For Tourism, Service Industries And Investments (Mwathi&Kagiri, 2014). It Is Also A Determinant Of The Type Of Infrastructure To Be Put In Place Hence Its Importance In Rural Economies. Mwathi And Kagiri (2014) Emphasize The Need For Community Types Of Setups For Meaningful And Sustainable Development However Recommends For Further Research On Strategies That Players Employ To Increase Their Attractiveness And Sustainability. Markey Et Al. (2006) Agrees That Rural Areas Are Perceived As With Limited Development Opportunities Hence A Community Oriented And Territorial Approach Will Be More Successful Than A Top Down Industry Based Approach.

new approaches to rural development are aimed at sustainability of the processes of the development agenda. experts argue that the top down approach is to be interchanged with the bottom up approach which yields better results increasing ownership and participation by the communities (limkriengkrai, 2010). participatory development is another approach that involves stakeholders in the development processes, participate in the design, implementation and evaluation of development interventions. sustainable development as a new approach is directly linked to an environment focus development agenda with economic and social benefits. richards argue that the social aspect of the development should be an approach by itself towards rural development focusing on culture and key issues such as gender (richards, 2013). sustainable livelihoods are also a new approach used for rural development which focuses on livelihoods as a means of achieving sustainable poverty eradication. booz (2013) points out that sustainable development is through supportive environments for the community systems for services or products and the durability or sustainability is achieved by the continuous supply of this benefits socially, economically or environmentally.

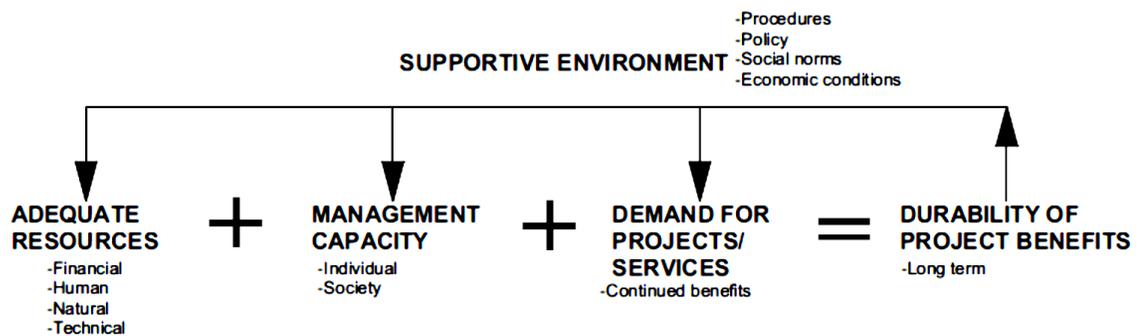


DIAGRAM 1. DYNAMIC SUSTAINABILITY COMMUNITY DEVELOPMENT MODEL. SOURCE, BOOZ (2013).

akpomurie (2011) proposes the merge of traditional culture and imported cultural skills to attain sustainable development in the rural areas as a concept. this argument is based on the fact that knowledge is passed from generation to generation in a sustainable way over the years thus equals to development. kothari (2007) agrees that people have their own solutions from practice, traditions and cultures if utilized are sustainable. the merge of tradition and modern aspirations can be achieved through participation for sustainable development.

the brundtland report of the 1987 world commission on environment and development, merged development to the environment. the report cited sustainability of development as highly dependable on the bridge concept of economics, ecology and ethics with the ownership of the concept spread across all sectors (bruntland, 1987). cases in africa, many parts of latin america, asia and middle east indicates that the major causes of political unrest and international tension is related to environmental decline. critical survival issues were reported to relate to uneven development, poverty and population growth. bruntland proposed an interdisciplinary and integrated approach to be used for the development processes. the development concept was linked to environmental sustainability, economic and ecological policies under a cause and effect theory (uncsd, 2007).

development processes for the developing and developed nations have since followed the bruntland model but adjusted to fit its cultural and economic context. the rationale of a sustainable development process being based on the assurance of renewable economic, social and cultural benefits to the community and its environment (richards & hall, 2000). more stakeholders are involved in the processes with gradual integration of the community, in some cases, they are driven by the community entirely (limkriengkrai, 2010).

## **COMMUNITY DEVELOPMENT**

A community is defined as an existing or potential system of individuals, groups and organizations that possess common concerns, interests and goals (Bush et al., 2000). Aref and others (2010) describe the community as a group of individuals residing a similar geographical area with common cultures. Development in this definitions is related to the

area where these groups live and related directly to their activities economically or socially.

Community development is introduced within an area for the purpose of the wellbeing of the people and the environment especially in rural settings. Key drivers being the provision of economic opportunities through meaningful employment for members, community revitalization, value addition to an existing system especially conservation projects, it is also a source of financing of other projects such as infrastructure and education. Community development is also introduced as a means of revitalizing intangible or tangible culture such as cultural events, festivals, local handicrafts and traditional farming practices.

It is worth noting that creating communities that work socially, economically and environmentally for long term basis is still a major challenge in our current generation (Woodcraft et al., 2012). Other barriers identified for community development include lack of or poor education, business experience, insufficient financial assistance and conflicting vested interests. Okazaki (2008) pointed out that varying degrees of involvement must be assigned to different evaluations and forecasts in the process for them to work efficiently. Richards (2003) agrees that creative processes from the inception to post implementation are to be introduced involving all stakeholders in such a way that ownership is created and decision making is shared at different stages.

The development process generally follows four key stages from inception to full maturity and up scaling though varies with population size, cultural context, local needs, development intensity and previous planning efforts (Reid et al., 1993; Okazaki, 2008).

#### **A) INCEPTION**

this is the ideation stage of community development. the new idea or concept should be more strategic and future thinking or visionary in development approach (reid et al., 1993). initial community assessments are carried out to harness the experience, expertise, desire and support of the local residents together with stakeholders generating inventories of perceptions about development related changes depicting experiences, concerns, hopes, fears and dreams. pinel (1998) cites this as crucial for making more informed decisions while building organization and infrastructure capacity. a good ideation is a

flexible and responsive process due to cycles of growth or decline influenced by relationship, roles and changes of stakeholders as recommended by woolcock & narayan (2000).

## **B) CAPACITY BUILDING**

the idea of the development is widely shared among stakeholders directly linked to the development or indirectly linked. relevant training takes place with the community at different levels from members, management, policy makers, beneficiaries and stakeholders to arrive at a decision or way forward to proceed.

## **C) IMPLEMENTATION**

the community project is initiated in an actual setting. the implementation is first done by the stakeholders or the funder then later gradually left to the community to own the project a common practice in many developing countries. experts point out that participation is very key for a community development project to succeed and that projects should be community driven from inception to implementation for sustainability to occur (richards, 2013).

## **D) ASSESSMENT AND UP SCALING**

assessment allows the development system to be guided and massaged by the community, area and market conscious inputs. feedback loops refines the community products and services towards success attributes of quality services, quality experiences, good value and allow necessary infrastructure around the community.

up scaling should be compelling from adequate assessment of the community. according to brooks (2008) this stage is more engaging and is built upon the authentic values of the community since inception.

## **DESIGN APPROACHES**

Van Der Ryn and Cowan (2007) describe design as an idea and a process about user

needs or wants becoming tangible. Design further is described as a strategic problem solving process that drives innovation, builds business success and leads to a better quality of life through innovative products, systems, services and experiences (WDO, 2017).

Design approaches used includes participatory or co-design, design thinking, immersions, empathic design, experience design and systems design among others. These design approaches results to more uptake of sustainable methods focused on design attributes and benefits the end user or community. Sustainability is provided by the broader context of a process that is more responsible, synergetic, contextual, holistic, empowering, restorative, eco-efficient, creative and visionary as described by Bharma and Lofthouse (2007, pg. 29). In a community setting, sustainability is established in the plan as product innovations, operations, value additions, competition, cost effectiveness and environmental responsibility through the intermarriage of systems and their characteristics as social, enterprise and product/service systems (National Research Council, 1999; Ngayu, 2011).

<b>SYSTEM</b>	<b>DIVERSITY</b>	<b>EFFICIENCY</b>	<b>ADAPTABILITY</b>	<b>COHESION</b>
<b>Product system</b>	Multiple product configurations and extensions	Value delivered relative to total cost ownership	End user product, customization, failure recovery, organizational learning, cash reserves	Strong brand, identity, unique product features
<b>Enterprise system</b>	Encouragement of diverse business strategies	Efficient decision processes, resource productivity	Organizational learning, cash reserves	Distinctive corporate culture, strong partnerships
<b>Ecosystem</b>	Biodiversity in terms of species variety	Efficient ecological cycling of	Tolerance and assimilation of exogenous	Natural habitat boundaries, tightly clustered food web

		energy and nutrients	burdens	
<b>Socio-economic system</b>	Ethnic, cultural, institutional and political diversity	Cost efficient means for human needs satisfaction	Transparency and flexibility of major institutions	Geographic boundaries, strong national identity

Table 1. Characteristics of sustainable systems. Source; National Research Council (1999).

The design approaches follow the design process as used in practice. The design process are planned out steps followed to achieve the desired output mainly used to solve complex problems that the cause of issue or resultant action to be taken to solve are not well defined. Different processes are used as per one’s understanding of the design tool. The common application follows the definition or exploration of the problem at hand, developing concepts to try solve the problem, testing of the possible solutions and delivering the final output in a convergent and divergent of ideas from abstract issues to tangible solutions.

Example of design process tools;

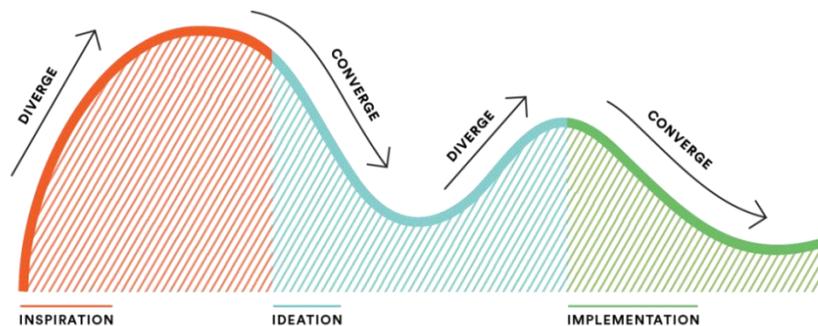


Diagram 2. IDEO Kit: Human Centered Design process. Source;

<http://www.designkit.org/methods>.

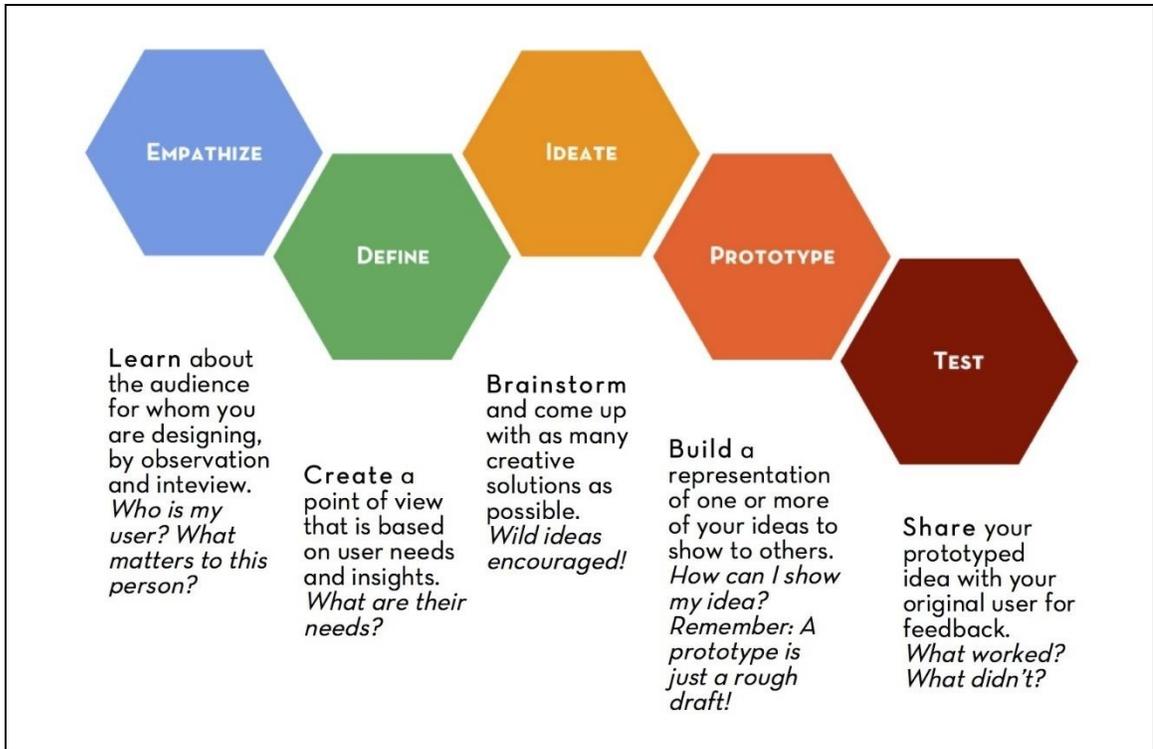


Diagram 3. Design thinking tool kit. Source; Design work book MIT d.lab.

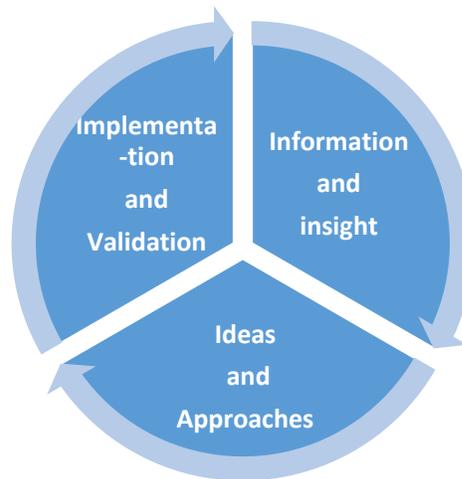


Diagram 4. The Design Spiral. Source; design Work Book MIT d.lab.

The research however focused on immersion design approach and participatory design as key social design tools that could be explored for handicrafts community development. In both processes, the designer is directly involved in context observing, asking and trying as a method of learning by doing and translating ideas to solutions in analogous settings.

**a) Immersion design approach**

The design approach involves getting involved in the communities' activities or problem situations by observing, asking and trying as key tools (Mijthab, 2016). The design approach referred to as **Empathic design** in some cases, uses analogous settings to solve what is seen as complex problems and seek inspirations. It is carried out as a form of design research or practice base research led by or with a designer. It focuses on the broad patterns of everyday life that are important and relevant specifically for the conception, design and development of new products or services or systems. Approach can also be used to orientate, frame and inspire a design or development project.

Tools commonly used in this approach includes affinity diagrams, coding, contextual enquiries, cultural probes, storytelling, design ethnography and design thinking (Salvador et al., 1999, Nova, 2014).

### b) Participatory design approach

It is also known as **Co-Design or Co-Creation**. Participatory design is an approach that attempts to actively involve all stakeholders in the design process to ensure the results are needs oriented and usable. Participation in design allows for opportunities, innovations and necessary decisions are not left out and are made by players or stakeholders in the early stages of design (Urban Strategies, 2008).

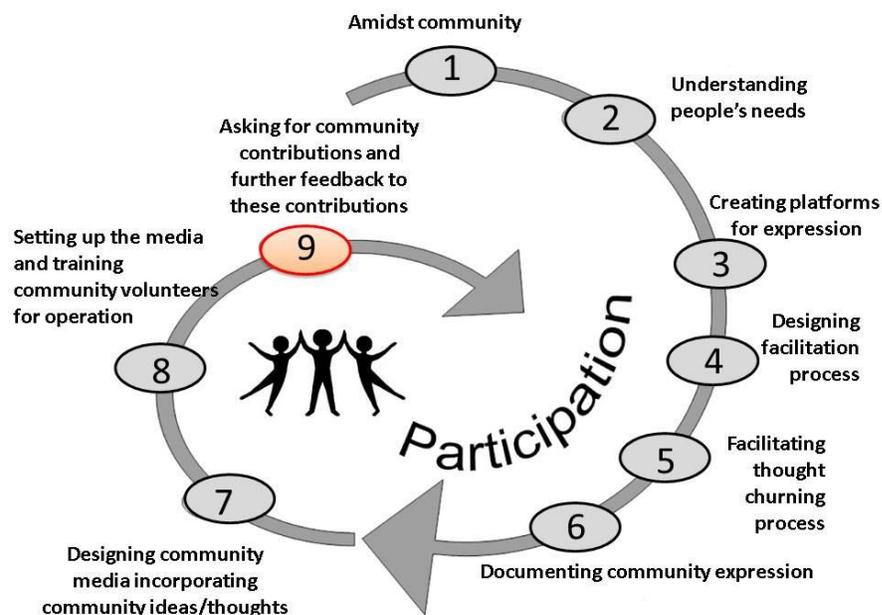


Diagram 5. Representation of a Participatory Design process. Source; Geerts (2016).

The design process involves directly the people you are designing for. The participants

are empowered to design and collaborate in the process. The mindset used is that people are experts and they know best about the problem and potential solutions. In community settings, people are far more likely to adopt a solution that they helped to create (Mijthab, 2016).

The steps applied in a co-design process involved identifying the people to participate. A stakeholder's analysis comes in handy at this stage as the relationships, interests and influences are established. An arranged space supplied with necessary instruments act as the creation space. The problems are then openly discussed, sketched out and concepts for possible solutions are built or designed. The people involved are treated like designers and experts. The feedback is captured and further processes are undertaken cooperatively. Participatory design tools commonly used includes Human centered design toolkit, Product Service Systems design modelling (PSS), community mapping (participatory 3D modeling, multimedia internet based mapping) and Design Oriented Scenarios (DOS) modelling.

## **METHODOLOGY**

The structure used for this paper is the IMRAD method which includes an Introduction, Methods used, Results and Discussions which is a common structural method for scientific papers as suggested by Sollaci and Pereira (2004).

The method used for this research is a Design research, which are mainly qualitative in nature focused on methodologies, practice and development undertaken by people with design abilities for unexpected results are produced thus innovation, invention and creativity terms are used (Hegeman, 2008).

The main research objective was to establish the application of design approaches in handicrafts community development. The other objectives were to determine the processes of community development and to examine the use of co-design and immersion design approaches in community development. The main research question was 'Can the application of design approaches effectively promote handicraft community development processes?'

The research was carried out in Wamunyu in Machakos County which is a home to an estimated 8,000 handicrafts producers practicing wood carving, weaving and drum making among others. The Wamunyu Handcraft Society was selected as the case study

purposively as it boasts of 2,300 handicrafts producers forming the largest group in the region. A sample of 50 people was selected for the study including society management, members and community members who benefit directly from the activities. Expert advice was sort for the research from the County government’s Ministry of Tourism and Culture, promoters and designers who practice social design. Focus groups were used for this purpose.

Data was collected through photographs, videos, field notes, instrument administrations, documents review, participatory community maps and systems diagrams. Data was then analyzed through accurate transcribing, mapping and scenario diagrams.

## **FINDINGS**

### **a) Wamunyu Handicrafts**

Wamunyu area in Machakos County is known as the factory of wood carving and are now celebrating 100years of this achievement of wood carving culture. The craft is practiced by over three thousand artisans both men and women along other crafts such as basketry, beading and drum making. Rural development is highly dependent on this activities and revolves around the products and enterprise systems.



Figure 1&2. Products at the Wamunyu Society showroom. Source- Author.



Figure 3&4. Artisans working in the workshops. Source- Author.

### b) Development processes

Development in Wamunyu is undertaken through communal systems practiced by the community under different settings as appropriate and convenient. Development support groups includes the Machakos County Government through the Ministry of Tourism and Culture as well Co-operative unions that the Wamunyu community are affiliated to such as the Machakos Co-operative union and the Handicrafts Society of Kenya.

The community development process revolves around the products produced and the immediate and long term benefits that are as a result to its members.

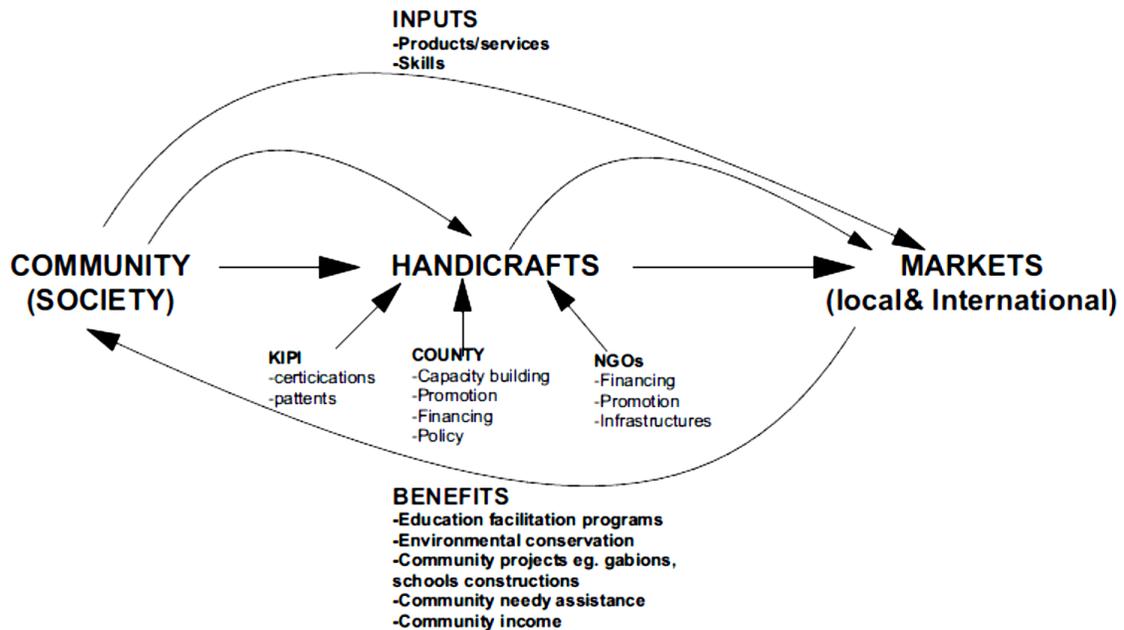


Diagram 6. Wamunyu Community development process. Source, Author.

The County and affiliated societies' development agenda is based on the promotion of the handicrafts products and activities in Wamunyu as well as other areas where handicrafts are practiced through marketing, capacity building, financing and value additions.



Diagram 7. Machakos development process (County cultural office, 2017).

### c) Immersion design approach

The field research was aimed at understanding the existing or expected product, service or systems around the community recorded through sketching, field notes, contextual interviews and photographic evidences. The focus was on the broad patterns of everyday life of the community an important activity for the design development of new services and systems. Participants were homogeneously selected corresponding to the same criteria to provide a better focus and safer conclusions, however, comparative, extreme and beyond users was also selected for study. The researcher participated in the daily activities of the community in an immersion process to speculate new ideas and ground theories.

Areas observed that the community is involved in included the acquisition of raw

materials, design process for products, tools and techniques used, production, presentation at sales points, packaging and selling of the products. The types and styles of the products were as well recorded. The utilization of the community spaces was also observed.



Figure 5&6. Types of products on display in the showroom. Source- Author.



Figure 7&8 Member of the Muuo Women Group with her products. Source- Author.



Figure 9&10. Artisans working in the workshop shades. Source-Author.



Figure 11&12. Learning by doing. Source-Author.

Inspiration were sort from daily activities of the paricipants and the methods used to build the community. Anologous settings were used to experience the benefits from other members that are not related to the handicrafts production or marketing. The activity was used to forecast unseen challenges related to the community processes.



Figure 13. Analogous inspiration (Hotel User experience). Source- Author.

#### **d) Co-design design process**

Data collected from the community through interviews and questionnaires indicates that 80 percent of the community members in Wamunyu are not involved in the planning process of the community projects. Members forming 15 percent are involved at managerial positions, stakeholders or as committee members in the planning process. 90 percent of the community individuals participate because they are registered members in the projects with 10 percent participating from free will. A large percentage (95%) would like to be involved in the initial design of their community development projects as others (5%) feel the responsibility is given to the community leaders such as the government elected officials citing members of the county assemblies, members of parliament, cultural officers, village elders and church leaders.

Participation are driven by benefits incentives from the community projects. It is also driven by the economic activities association of the projects as the members will participate if it is related to their daily activities. The majority of the community members participate in handicrafts production and sales forming 85 percent of the community. The co-design tool selected was the Human centered Design toolkit giving the community the chance to source inspiration, ideate new concepts, prototype and represent innovative solutions for their development agenda. Visual models were used to aid the design process considering the rural context where communication challenges were expressed. Participants were drawn from different stakeholders in the handicrafts sector directly involved in Wamunyu community activities. The location of the workshop was at the Wamunyu handicraft society compound as it was easily accessible by all and allowed for

different settings of materials to be accessed by many participants at the same time. The workshop was carried out in two key stages for maximum input advantage into the possible solutions provided.



Figure 14. Preparation of visual models and workshop materials. Source- Author.

## STAGE I

The participants were introduced to design techniques for problem solving and a simple design thinking process was agreed upon. The design thinking activities identified possible problems associated with the community development of the handicrafts and quick solutions as observed by the participants written on large sheets of paper pinned on the wall. Quick concepts were sketched out for better understanding of possible solutions agreed by the participants. The process was also used for stakeholders and process mapping.



Figure 15&16. Participant on the design thinking process. Source- Author.

## STAGE II

The participants were involved in the design process developing more concrete concepts as to the problems identified in the design thinking process in the earlier stage. The concepts developed included making of drawings of the ideas, selection of working concepts and quick dirty prototyping.



Figure 17. Co-designing process with the marketing team. Source – Author.

The participants sourced out inspiration from their experience in and out of the country, other communities and futuristic visions or expectations (design fiction). The discussions were around what works and what does not work, why it doesn't work and which is the best balance or compromise as the knowledge is shared between stakeholders.



Figure 18 &19. Concept developed for signage. Source- Author.



Figure 20&21. Concept developed for packaging of products. Source- Author.

Participatory 3D (table) models were also used by participants for community space planning as the community handicrafts society existing land had no actual plan when constructing structures, shared spaces or common areas. The participants used the model to redesign the space to accommodate future additions of structures, parking spaces, walkways, maximize space and create scenic views of the area.



Figure 22&23. Images showing existing structures and space use. Source- Author.



Figure 24. Participants taking part using a participatory 3D model. Source- Author.



Figure 25. Resultant space plan from the Co-design process. Source- Author.

### STAGE III

The final stage was to test the end results and refine for application or uptake as a proposal. The stage involved expert advice from a selected team of practitioners in the handicraft development sector and a designer. The team was introduced to design thinking as a method of assessment and evaluation of the participants' outputs.



Figure 26. Expert focus group inputs workshop materials. Source- Author.

Other cases were also looked at as comparative studies around Katangi area and kathiani area in Machakos County for this assessment of outputs. The comparative inputs were used to refine the proposed processes and adopt successful scenarios.



Figure 27&28. Images from other community processes. Source- MCU.



Figure 29. Products from other handicrafts communities. Source- Author.



Figure 30&31. Community products standardization tools. Source- Author.

The feedback derived from all the three stages indicated that design approaches are easy to comprehend and gives the community participation opportunities that lacked in many community development processes. The approach used inspired mindset change towards development processes and future aspirations. Participants cited appreciation to be part of the team as they have always had and withheld ideas for lack of better channels to communicate them through. The feedback from the focus group of experts and the government representative identified this a good approach to implementing community based projects and bridging the gaps as many are initiated by organizations and not from the community.

Suggestions that were identified from workshops were time related. Longer durations for the stages were proposed with more participants tackling different issues with given scopes. Parallel approaches were proposed to be used at the same time as participants preferred one more than the other. It was also noted that participants are at different levels of understanding of the processes, more visual tools were suggested for this purpose both audio and visual.

It was also proposed that the younger generations to be involved more in such processes for continuity. Men were more actively involved than women in all the design stages, experts attributing this to the cultural setting of the community and unequal education

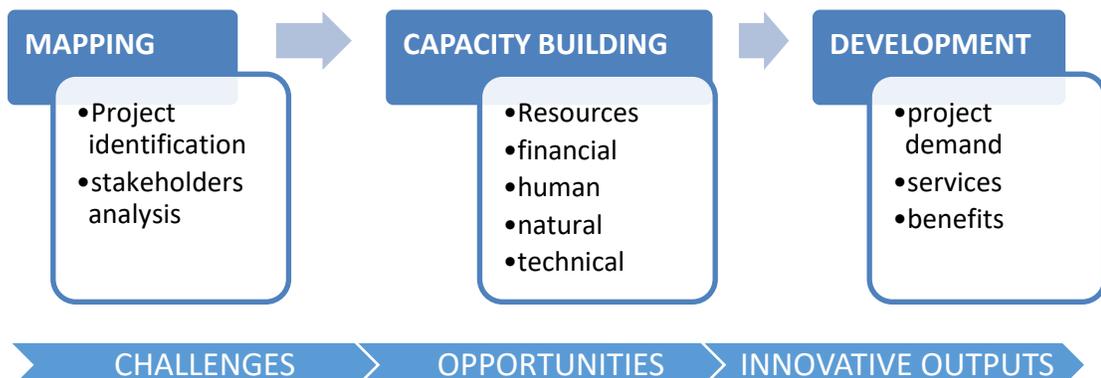
levels among the different genders. Separate workshops and activities were suggested.

## CONCLUSIONS AND RECOMMENDATIONS

Design led solutions offers a great opportunity for African designers in solving what are considered as complex problems in many fields. The multidisciplinary approaches offer better, cheaper and more sustainable tangible solutions as the situation is addressed from different angles and views of the stakeholders. Collaborations for long term partnerships are enhanced leading to sustainable change.

Design approaches gives the general community the chance to be innovative in problem solving which is beneficial in sustaining the rural communities both socially and in products design and production. Innovative solutions through design can sustain rural development as it is a people driven approach. Design approach offers creative facilitation and presentation techniques to the disadvantaged rural majority. It also uncovers tacit knowledge providing enriched data for development, policy and research. Increased participation ensures that the development goals are achievable as the people are the experts of their own systems socially, economically and environmentally. The needs of the community are well captured and addressed in the process.

This paper recommends the adoption of the design process and design approaches for community development from the inception or ideation stage to the last phase which is implementation. The design approaches are also recommended in the project evaluation stages to site and solve emerging problems and developing future agendas or objectives for the community.



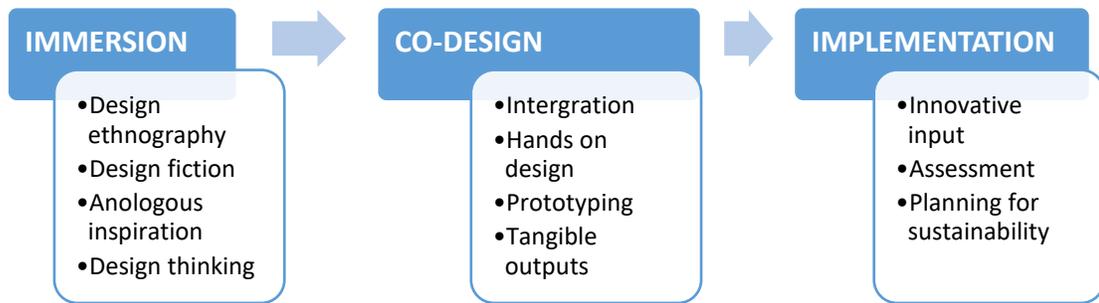


Diagram 8. Proposed Development model. Source-Author, 2018.

The flexibility and needs driven structure of the design process and approaches make it suitable for any field or area of development in any sector that communities are involved in for socioeconomic and environmental sustainability.

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# **Assessment of ECOWAS Free Movement Protocol in Promoting Regional Growth and Development in West Africa**

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## **ABSTRACT**

This study will critically assess the Economic Community of West African State [ECOWAS] on its activities on regional integration, growth and development as a panacea to regional free movement of people and goods. ECOWAS was formed in 1975 with the objectives of among others facilitating economic development, fostering relation and promoting peace among her members. In her efforts of achieving these objectives, several protocols among which the protocol on free movement of people was adopted aimed at removing all obstacles for the movement of people across the subcontinent. Although, success have been recorded in removing all kind of visa requirements through the introduction of one passport, less have been found to have achieved of its much expectations. Non harmonization of currency, poor political commitment and existence of multiples checkpoints hampered the success of the protocol. This study examined the success recorded and the challenges that hijacked the full implementation of the protocol; About a half a century of its creations, ECOWAS in spite her remarkable achievements in promoting unity, maintaining peace and enhancing political and economic relations, have yielded less particularly in relation to the implementation of the free movement protocol. Though, movement of goods and people is much more advanced in comparison to the earlier years of decolonization, it is still bedeviled by so may be abuses. Since majority of West African people are not highly educated, there is the need of informal education system to acquaint people with the basic formalities or requirement involve in their cross border affairs within the sub region. There is also need for the automation of immigration and custom services to help fasten the procedures of border administration. The present manual system was found not suitable in the contemporary world.

**Key Words:** ECOWAS, Free Movement, Success, Challenges

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## 1 INTRODUCTION

The quest for among others accelerated economic and political development by West Africa Countries after their political independence ignited the desire of sub-regional integration a decision which climaxed in the formation of Economic Community of West African State [ECOWAS]. ECOWAS was established on May 28, 1975 with a treaty signed in Lagos by sixteen West African Countries of Benin, Liberia, Burkina Faso, Cape verve, Cote D' Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo and Mauritania; although, Mauritania voluntarily withdraw her membership in 2002 (Butu 2013).

The objectives of ECOWAS was to promote sub-regional cooperation leading to the establishment of an economic union in West Africa to be saddled with the responsibility of raising the living standards of its citizens, enhancing economic stability, fostering relations contributing to the general progress and development of the African Continent. To actualize these objectives, several protocols have been adopted one of which is the Protocol on Free Movement of People. The protocol relating to free movement of people was adopted in 1979 by Protocol A/P.1/5/79 which propounded the right for entry, establishment and residence of ECOWAS citizen among member nations.

Free movement protocol is a trio phase approach policy with the first phase (I) provided for the elimination over five years of the requirements for visas for the entry of community citizen into another member land. Phase II was provided the right of residence including the right to seek and carry out income-earning employment, while Phase III focused on the facilitation of business through the right of Community citizens to manage economic activities in member states other than his states of origin.

Since its birth about half a century, ECOWAS recorded numerous achievements which include the removal of visas and the introduction of single passport. However, it was abuse of not meeting much of its expectations. This is more pronounced in the words of (Adepoju, Boulton & Levin 2010) *“though freedom of movement in the ECOWAS region is undoubtedly more advanced than in any other regional grouping in Africa continent, the objective of complete freedom of movement in the sub-region*

*has not yet been realized.”*

It is against this background this research was designed to explore the extent to which free movement protocol have been implemented among the ECOWAS Countries and to examine how it impact on the economic prosperity of the sub region.

## **1.2 STATEMENT OF RESEARCH PROBLEM**

The major problem which informs this research was the compounded implementation challenges of the protocol. With the four decades of free movement protocol, successful implementations among members remained less of expectations. Community citizens were denied entry into another Member States; harassment by security operatives, extortions at border points, illegimate deportations and above all excessive border control system featured most of the journey. Another problem well noted in the extent literature is the perennial economic misery of the ECOWAS countries. It is less arguable that West African Countries are among the poorest economies of the world and majority of them filed the list of Heavily Indebted Poor Countries (HIPC) (ECA, 2011; Global Competiveness Index 2014).

This study should therefore explore the extent to which the free movement protocol contributes to the economies of the ECOWAS Members and to determine the factors that militated against its implementations

## **1.3 OBJECTIVES OF THE STUDY**

The general objective of this study is to explore and determine the extent to which the free movement protocol has been implemented and assess the factors that militated it proper implementation. The specific objectives include;

1. To determine the degree of implementation of the protocol among the Member States.
2. To determine the factors that militated against its implementation.
3. To recommend strategies to overcome the implementation challenges.

## **1.4 RESEARCH QUESTIONS**

The following are some of the questions raised by this research.

1. To what extent has the protocol on free movement been implemented among the ECOWAS States?
2. What are the factors that hindered the performance of the protocol?
3. How should the problems of poor implementations be solved?

## **1.5 SIGNIFICANCE OF THE STUDY**

The advantage of this research lies in her objective of critical assessment of the implementation of free movement protocol among the ECOWAS Member States and to examine the factors that militated against its performance on the same paper. The study should also be finding useful for ECOWAS Member States to utilize its recommendations on adopting sound policies for overcoming the overall integration challenges of the sub-region. To the general body of knowledge, it should be finding useful for other researchers in the area.

## **2.1 LITERATURE REVIEW**

Since World War II, efforts towards regional integration increases immensely around the world. Although earlier effort is geared toward preventing conflicts, the contemporary momentum according to ECA (2004:9) is predominantly economic inspirations. ECA (2004) defined integration as a preferential (usually reciprocal) agreement among countries with the proposed objectives of removing or limiting barriers on economic and noneconomic transactions. Such an arrangement can take different forms depending on the objectives and the intensities of the integration.

On the political perspective, Haas (1958) in Dosenrode (2010:4) defined it as a process whereby political actors in several distinct national settings are persuaded to shift their authorities, expectations and political wills for a new center (supranational) whose institutions possess or demand higher autonomy and jurisdiction over pre-existing national authority. Butu (2013) defined integration as a system of cooperation in which States agreed to forgo the ability to formulate policies independently on matters concerning trade, customs and immigrations.

It is unarguably true that removing impediment will create an enabling environment

for international flows of wealth and skills. This was also true in the words of ECA (2004) *“that removing all barriers for cross border right of people will help promote a sense of belonging, ensures movement of technical know-how across national borders and help build and expand labour markets.”* This contention is also right of (Ukhaoha & Ukpe 2013; Garza, 2006) who opined that when people are free to move from one nation state to another, they carry along with them not just their skills or technical know-how, but also physical articles of trade. To them these will enable in wealth creation as well as redistribution of such wealth within the group. In the same vein, (ECA 2011:23 Awumbila et al 2014:15) opined that for a country to reap the benefits of economies of scale, it most guarantees an expanded market by widening her economic scope. This argument was based on the assumption that revitalized regional integration offers one of the most credible strategies for tackling developmental challenges of nation states. Lee (2002) and Ejime (2011) stressed that integrating economies and political structure of nations will facilitate the achievement of accelerated and general development.

Studies in (UNECA 2013; Bamfo 2011; Touzenis 2013) have also posited that a strong and vibrant integration is a tool of minimizing political violence, eliminating civil conflict, arresting poverty and ensuring harmony among nations. This was also true of Butu (2013:50) who posited that cooperative action among nations will certainly help address the peculiar problems of agriculture, manufacturing and infrastructural decay and ensure even development.

Nevertheless, in spite the ability of ECOWAS to survived myriads of challenges over the years, the purported goals of integration remained a mirage. Report in UNECA (2013) stated that West Africa countries that comprised ECOWAS are the countries with the lowest GDP, high poverty incidence, lower per capita income, weak state institutions and poor infrastructures (UNECA 2013; UNECA, 2011). A situation which Bamfo (2013:13) attributed to the political, economic and social factor of the sub-continent. Other challenges according to Awumbila et al (2013) were the inability to offer financial obligations by Member States. However Touzenis (2013) posited that: National security threats, protection of national employments, protection of infant industries, lack of adequate mechanisms to facilitate and manage

labor mobility within the region and beyond, non-reliable Labour market information, and non-recognition of different education/professional certificates among members are the factors that undermined the success of the protocol.

### **2.2.1 FEATURES OF THE FREE MOVEMENT PROTOCOLS**

The major feature of the free movement protocol is in its provision of Article 2.1 which posited the right of Community Citizens to enter, reside and establish within the territory of another member state (Article 2.1). Subject to this provision, it established three-phased approach to be realized within a time frame of 15 years i.e. five (5) of each phase.

Phase one forthwith provided (ECOWAS 1979, Article 3.1) for dispensing all necessities to obtain a visa for entry to another Member State for a period of time not exceeding ninety days (Article 3.2).

Phase two was propounded by the supplementary protocol of 1986 Protocol No. (A/SP.1/7/86). It provided for the right of residence and the ability to engage in an incoming gaining employment in another Member State. It stipulated that a community citizen shall among others the right to apply and offered an employment.

The third phase is the rights of establishment of persons in the territory of another member state (Protocol A/SP2/5/90). The protocol defines the right of establishment to mean the right granted to a citizen who is a national of another Member State to settle or establish in another Member State other than his state of origin and to have access to economic activities, as well as to set up and manage enterprises particularly companies under conditions defined by legislation of the host state

This also includes equal opportunity for creation and management of enterprises and companies in other member States other than their country of origin (Protocol A/SP2/5/90).

### **2.3 THEORITICAL FRAMEWORK**

There are myriad of theories explaining the various types, forms and process through which nations goes about integration. The basis of the differentiation of these theories seems to be lied in their respective importance attributed to economic and political factors and the institutionalization involved. Among such is the neo-functional theory of integration and which is the central tool of analysis in this study

is more synonymous with the European integration process that propounded the contemporary European Union (EU). The earlier work of this thought was traced to Jean Monnet (France Prime minister) in 1951. He (Monnet) was regarded in modern academic literatures as the founder of the modern European Union. While Monnet was well noted in modern literature as the founder of neofunctionalism, although, its theorization was nevertheless traced to the work of Ernst Haas (1958) in a seminarian work "*The Uniting of Europe*" in 1958 (Dosenrode, 2006:6). Since then, Haas continued to contribute upon which other major contributors to neofunctionalism like Leon Lindberg (1963), and Philippe Schmitter (1969, 1971) got their basis (Dosenrode, 2006:6).

Haas idea was an expansion of David Mittrany's functionalism and Monnet's idea of European integration. He combined functionalism with inspiration from Jean Monnet's pragmatic approach to European integration. Contrary to the functionalist prepositions, Haas and his followers looked at regional integration as a non-universal activity and political process, but not as merely functional or technocratic idea projected by the functionalist.

Advocating at his time for the concept of neo-functionalism, Jean Monnet (1951) stressed the importance of development of some central institutions that will be bestowed with the roles of overseeing and directing integration processes. Monnet's assumption was that, integration process cannot be limited to certain technical areas as advocated by the functionalist nor it to be seen as a deliberate act of supernaturalism of the federalist. But to him, states should sort out activities that are specifically defined and are politically important for them. He for example used the goal of integrating the coal and steel market to expand into social security and transportation policies. Unlike the functionalism who believed in conscious political decision in the act of integration, neo-functionalism was based on the assumptions that the deliberate merger of economic activity in particular economic sectors will ignite for a wider economic integration that would spill over into broader political integration in the long run. On his side, Haas also opined that once integration was launched in one sector, there should be more pressures for further integration in other areas from social and economic groups that were entice with the earlier process and

hence demand for broader integration in other areas. The benefits of the economic union will definitely create tensions from civil and economic groups for the expansion into broader scope and gradually into complete political union. Ernst Haas spill-over process was also applied by Lindberg. According to Lindberg (1963), spill-over refers to a situation in which a given action, related to a specific goal, creates a situation in which the original goal can be assured only by taking further actions, which in turn create a further condition and a need for more action, and so forth (Lindberg, 1963: 10)

### **3.1 METHODOLOGY**

This is a documentary research that utilized information from the secondary source. Data was obtained from written materials; some are published and others not published. Presentation is through both quantitative and qualitative methods.

### **4.1 AN ACHIEVEMENTS OF THE FREE MOVEMENT PROTOCOLS**

A general assessment into ECOWAS performance over the years should undoubtedly revealed that the union has achieved much since her creation. One of such credit is the ability to of the Commission to survive the perennial challenges of economic and political upheavals which have bedeviled almost all West Africa Countries. It is non disputable that countries in the West Africa are among the poorest economies of the world and the three (Niger, Mauritania, Mali) filled the last three digits on the poverty index countries (UNDP, 2013). On the political arena, ECOWAS was hallowed with multifarious instabilities of civil wars, ethnic clashes, religious conflicts, military coups, terrorisms and border disputes among others. According to Bamfo (2013), the political challenges of ECOWAS were rooted in her founding fathers because the Commission itself was rooted to ideas of military juntas in West Africa (Gawon of Nigeria and Eyadema of Togo).

#### **4.1.1 ABOLISHMENT OF VISA**

One of the greatest achievements of ECOWAS in the implementation of the free movement protocol is that, it has succeeded in abolishing visa requirement for

community citizens among her Member States. Today, it is commendable that movement within the ECOWAS States required no visa for community citizens. Since 2003, several countries have also launched the new ECOWAS passport while some have also succeeded in harmonizing their emigration and immigration laws. For example, ECOWAS travel certificate is currently used in Burkina Faso, The Gambia, Ghana, Guinea, Niger, Nigeria and Sierra Leone (Adepoju et al 2013:5). Below is the presentation of the level of implementations of the various free movement initiatives of ECOWAS.

**Table: 4.1: Implementations of free movement protocol among ECOWAS countries:**

S/N	Country	Abolishment of Visa and Entry Permit	Introduction of ECOWAS Travel Certificate	Introduction of Harmonized Immigration/E migration Laws	Introduction of ECOWAS Brown Card
1	Benin	Yes	No	Yes	Yes
2	Burkina Faso	Yes	Yes	Yes	Yes
3	Cape Verde	Yes	No	No	Not Affected
4	Cote D'Ivoire	Yes	No	No	Yes
5	Gambia	Yes	Yes	No	No
6	Ghana	Yes	Yes	Yes	Yes

7	Guinea	Yes	Yes	Yes	Yes
8	Guinea Bissau	Yes	No	No	Yes
9	Liberia	Yes	No	No	No
10	Mali	Yes	No	Yes	Yes
11	Niger	Yes	Yes	Yes	Yes
12	Nigeria	Yes	Yes	Yes	Yes
13	Senegal	Yes	No	Yes	Yes
14	Sierra Leone	Yes	Yes	Yes	Yes
15	Togo	Yes	No	No	Yes
	100%	100	47	66.7	86

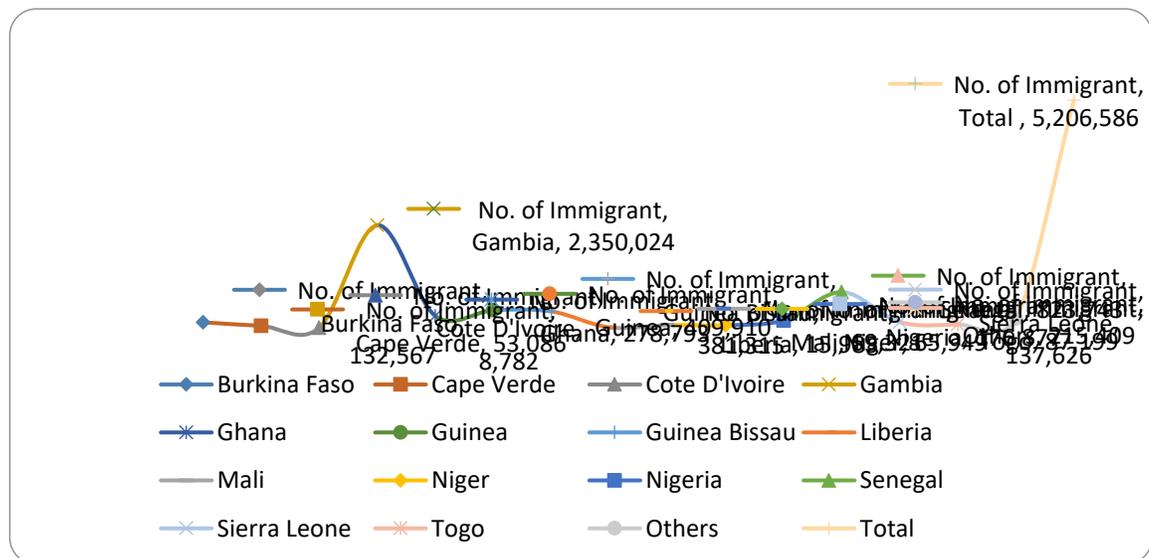
**Source: Butu (2013), Awumbila et al (2014:103) Adepoju et al (2010:5).**

In a percentile distribution as presented in the above, ECOWAS was 100% successful in the abolishment of visa requirement for the entry of community citizen into another member state. It is also 47% successful in the implementation of uniform travel document. For the harmonization of emigration and the immigration laws, 66.7% of the goal was so far achieved as six of the member states (Cape Verde, Cote D'ivoire, Guinea Bissau, Liberia and Togo) were yet to formalize. 86% achievement was also ascertained on the introduction of ECOWAS brown card; twelve Members of Benin, Burkina Faso, Cote D, Ivoire, Ghana, Guinea, Guinea Bissau, Mali, Niger, Nigeria Togo Senegal and Sierra Leone have introduced brown card, Liberia, Gambia and Liberia are being awaited and Cape Verde is not affected because of its geographical location.

#### 4.1.2 RIGHT OF RESIDENCE WITHIN ECOWAS STATES

On the implementation of the second phase of the protocol, ECOWAS have also recorded notable achievements. West Africa today is among the highest migrant producing region of the world. Studies in (Touzenis, 2012; ECA, 2011) revealed that West Africa is the region that has the highest number of immigrant people and most of these migrants rooted from the West African sub-region. An estimated 3% of the 350 million populations in the West Africa sub-region are migrant workers (Awumbila et al, 2014) and were dispersed within the sub region. A development which (Bamfo, 2012, Ejime 2014) attributed them to the success of the implementation of the free movement protocol. Addo (2013) posited that, as part of the achievement of the free movement protocol, almost all ECOWAS countries are both migrant-sending areas and immigration destinations. Below is a summary distribution of West African Citizen in another member states.

**Graph: 4.1: Distribution of West African Immigration among Member States:**



**Source: Awumbila et al (2014:23).**

From the above table, it was found that Côte d'Ivoire had the highest number of ECOWAS immigrants (2,350,024), followed by Nigeria (823,743), Ghana (409,910),

and Guinea (381,315) while Gambia have (278,793) among others. Côte d'Ivoire therefore remained a most popular destination for ECOWAS migrants. Countries that receive the lowest number of ECOWAS migrants are Cape Verde (8,782), Guinea Bissau (15,985), Burkina Faso (53,086) and Mali (65,949).

#### **4.2 FACTORS THAT HINDERED THE IMPLEMENTATION OF THE PROTOCOL**

Free movement protocol in spite the purported achievements over the years was nevertheless hampered by different implementation challenges. In comparison to the European Union [EU] where citizens can move freely from one member state to the other and transact with a single currency, ECOWAS have not succeeded in propounding a common currency within the sub-region. Concerted efforts since its creation always ended in deadlock. Today, there were about ten incompatible currencies in the sub-continent with only the Franc CFA having a wide coverage being utilized in almost all the French colonies of the union.

Infrastructural deficit is another band on the proper implementation of the protocol on the free movement of goods, services, capital in the ECOWAS sub region. The lacked of good roads, dilapidated rail systems and dulled seaports have hampered the free movement of goods among West African countries. It is non-arguable that the state of roads linkage in West Africa is pretty poor which have severely affected land transportation in the region. Founded by this scenario, the movement of goods and persons between countries is inhibited by higher losses of lives and property. Trailers and large luxury buses are always having difficulties in going through some of these roads in the region. In addition to this poor road system, there are also no rail connections between ECOWAS countries. It was clearly stated that irrespective ECOWAS countries the railway system was a colonial creation and unfortunately most of these rail system disappeared because of managerial negligence by the post-colonial elites. The inadequate and poor quality of transportation infrastructure in WestAfrican acts as a major hindrance to the free flow of goods across borders.

Poor machinery to checkmate the implementation of the protocol was seen as another reason that hampered the protocol, the lack of control system to regulate the

infiltration of criminals under the aegis of community citizen have largely affected the free movement protocol. It was found that ECOWAS has not instituted any mechanisms to control the movement of illegal immigrants into member states. This has over the years culminated into narcotic and human trafficking in addition to the movements of other deadly terrorist groups. These crimes and acts of economic saboteur have led to expression of resentment among officials and the general public in the destination countries.

The success of the protocol was also undermined by the non-harmonization of its laws with that of the domestic laws of member states. The existence of multifarious laws has adversely affected the smooth implementation of the protocol on free movement of persons. In enacting the protocol, much consideration was not given to the varying and diversities in social, political and economic background of the member states. Guided by some predisposing interests and tedious legislative processes, some states declined to harmonize their national laws with the ECOWAS provisions. Although, some of the national laws pre- exists the ECOWAS protocol, evident available proved that most of the countries lack the political will to sacrifice their sovereignty to any supranationality.

Poor political commitment by member nations to implement the provisions was also seen as another reason for the poor implementation of the protocol. The provisions of Article 3 of the supplementary protocol of 1986 (inadmissibility clause) which granted member states the right to deny community citizens the right of entry and or residence in their countries on the reasons of public order, public security and public health among others rendered a huge blow to the full implementation of the protocol. Over the years, entry denial through stringent migration policies, deportation of community citizens, harassments by security and the existence of xenophobia among the nationals featured the behaviour of many counties. For example, In July 2005, anti- migrant citizens in Gambia killed about 44 Ghanaians (Elumelu, 2013) this came after deportations exercise were completed in Cote D'Ivoire; Nigeria etc. Liberia has also completely prohibited non-nationals regardless of region or continent from establishing business in its territory.

## **5.1 CONCLUSION**

About a half a century of its creations, ECOWAS in spite her remarkable achievements in promoting unity, maintaining peace and enhancing political and economic relations, have yielded less particularly in relation to the implementation of the free movement protocol. Though, movement of goods and people is much more advanced in comparison to the earlier years of decolonization, it is still bedeviled by so may be abuses. There too many border restrictions which mostly rendered inaccessible for migrants a situation which was culminated into high level of illegal migrations through the porous border areas. The inability to guarantee good road network and railway system was also seen as part of the setbacks for the success of protocol.

## **5.2 RECOMMENDATIONS**

Since majority of West African people are not highly educated, there is the need of informal education system to acquaint people with the basic formalities or requirement involve in their cross border affairs within the sub region. There is also need for the automation of immigration and custom services to help fasten the procedures of border administration. The present manual system was found not suitable in the contemporary world.

Special regulatory teams need to be established by ECOWAS to checkmate the degree of compliance by border agents. If possible, extensive effort should be geared toward ensuring a single migration border to be regulated by the commission.

ECOWAS must oblige member states to provide valid travel documents to their citizens at a subsidiary rate. The current idea of exorbitant fee made the possession of travel document difficult for many travelers.

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**An Inquiry into Youth Innovativeness in Radicalization and Extremism:  
The Case of the Recent Manchester City Bombing and Al-Shabaab Activity in  
Kenya**

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**ABSTRACT**

The fulcrum of this paper is the May 22, 2017 Manchester City bombing. The paper seeks to highlight how the youth can become indoctrinated into extremism. It inquires into why some people go through the terrorism indoctrination cycle yet not progress to the critical point of carrying out terror acts. Whereas several scholars have challenged the whole radicalization discourse, their basis is on the vulnerability of people to extremism in Western countries, which this paper finds inadequate, as it does not address the root cause of the problem. The results of data analysis on the terror groups al-Shabaab and Mombasa Republican Council (MRC) has shown that the majority of youth joining the two terror groups do so at an early age ranging between 16 to 20 years of age and lack a good education. The Countering the Lone-Actor Terrorism (CLAT) project results has shown a relationship between mental health and terror acts. The point of concern in this paper is therefore, youth without a good education, who have first-hand exposure to violence indoctrination and or with mental health problems would be easier to radicalize to the point of carrying out acts of terrorism and extremism.

**Key words:** Terrorism, jihadist, extremism, depression, alienation, bombings.

**1.0. Introduction**

The Manchester Arena concert bombing in England on 22<sup>nd</sup> May 2017, resulting in the death of 22 people, bears the hallmarks of the typical modern terrorist operation. What is known about the bomber, Salman Ramadan Abedi, aged 22, is that he was the son of Libyan parents who fled Libya in 2011 to Britain where the family had resided for over a decade. Abedi's father, Ramadan Abedi, aged 51, is himself a committed jihadist who has been a member of the Libyan Islamic Fighting Group (LIFG) founded in 1995 to overthrow the Gaddafi government. The group, which is said to have links with the Al-Qaeda terror network, attempted an assassination on Gaddafi in the 1990s according to press reports. Following the overthrow of the Gaddafi regime by jihadists backed by NATO

forces in 2011, the family moved back to their home country (Roland Oliphant, article in The Telegraph on 24/5/17).

Abedi is believed to have participated in the father's jihad back home in Libya against the Gadhafi government when he was 16 years old (Bennhold et al, New York Times, 27/5/17). According to the BBC News, Abedi had earlier been arrested for what the Manchester Police said were minor offences of theft and assault in 2012. The New York Times report claimed that when he visited Manchester City earlier in 2017, he told people that he believed in dying for a cause and other similar jihadist statements about suicide bombings (BBC News, 30/5/17). Abedi's behavior has similarities with the model of offending described in Brame et al (2004) and Piquero et al, (2014) in their article 'Criminal offending frequency and offense switching', that investigated whether there existed a relationship between frequent offending and offense switching based on literature suggesting such a relationship. This can be described as a situation in which an offender who frequently commits crimes can change to other forms of crime when circumstances are favourable. This is exemplified by the fact of the bomber, Abedi, having been arrested for other offences earlier before he committed the current atrocity.

In a nutshell, the Salman family had been raised amid jihadist activities and extremist violence by the LIFG as it fought against the former regime of Gaddafi. The Salman sons were exposed to radicalization, first by their own father, and later among other extremist networks within the large Manchester Muslim community where they gained further jihadist ideas and beliefs that they evidently internalized to the point of actualizing them (Wikipedia article "Al-Shabaab (militant group)", downloaded on 29/5/17; Katrin Bennhold et al, in their article on 27<sup>th</sup> May 2017). This scenario fits the behavior of Abedi who the press has said was reported by fellow Moslem leaders in Manchester to the authorities no less than on five occasions for extremist activities. Viewed from the perspective of how people get entrapped into crime, Abedi's behavior is no surprise. It is well known in criminology that among the factors that can influence criminal behavior in a youth include peer pressure, the influence of and violent activities of the family members and the social organization surrounding the individual (Livingston et al 2014). The fact that Abedi grew up surrounded by people who viewed extremist violence as justified and normal greatly shaped his thoughts. His father's involvement in LIFG

activities greatly influenced his world view towards aggression and extreme violence. Hence the circumstances around which Abedi grew up shaped his behavior in ways that led him to view the use of extremist violence on what he considered enemies of Islam as being normal and justified.

## **2.0.Methodology**

This article used open sources in the media as well as a review of the literature to highlight the differing viewpoints of research. A comparative look at research studies by leading scholars of the subject as well as a review of current credible newspaper articles were utilized as a way of comparing the factors that influence the youth to become radicalized.

## **3.0.Factors that Drive Youth into Radicalization and Extremism**

The foregoing background about the environment in which the Ramadan family was brought up appears to be supported by a new research suggesting that terrorist and jihadists' actions of bombing and killing of innocent people could be the result of depression and isolation (Bhui et al, 2014). The study by Queen Mary University professor, KamaldeepBhui, released in September 2014, surveyed 600 Moslem men and women living in Britain aged 18-45 about their views on radicalization and extremism. The survey showed that those respondents who sympathized most with terrorist activities were more at risk of being radicalized than those who condemned terrorism who the study found to be less likely to become radicalized. Given these findings, the study postulates that social networks are crucial in helping people to connect and socialize with others thereby steering them away from possible mental breakdown that could lead to radicalization.

Neighbourhoods where one spends his/her formative years in life, literature on aggression and violent behavior suggests, has much influence on behaviour later in life especially if he/she witnesses violence in the family or sees it being practiced in the neighbourhood among or by gang or other group members (Vaughn et al, 2015; Kim and Lo, 2015). Looked at from this explanation, Abedi's family background and history fits the model described above. Another model is where a lone terrorist who does not have any links with a particular terror group but due to propaganda and other recruitment

literature and approaches, goes on to carry out a terrorist action (van Zuidewijn and Bakker, 2016).

Besides the theorization of the possible reasons why people become terrorists posited by the Queen Mary University, other scholars see such motivations differently. Some have suggested that the Western governments' shifting of the debate and focus away from the root causes of radicalization among Muslims, seen as being the result of meddling by the Western governments in Muslim countries, had resulted in an inability to properly address the problem of radicalization. This school of thought postulates that the West had put the discourse and subsequently the research spotlight on Islamist or jihadists' attempts at radicalization and recruitment of the youth in Western countries. By placing the emphasis on the 'vulnerable individual' and away from the main cause, the enabling environment, that is, meddling, Western governments had missed the point of focus (Schmid, 2016). This, they argue, is evident from the definitions of radicalization coined as a result of this practice, such as the one articulated by the European Union, thus: "Individuals or groups becoming intolerant with regard to basic democratic values like equality and diversity, as well as a rising propensity towards using means of force to reach political goals that negate and/or undermine democracy". Schmid has argued that this definition articulated by the EU is problematic since if democracy and diversity were the key issues in extremism, there would be much more terrorism in the world today than is the case in reality.

To support this argument, Schmid used two cases of Muslims who fall in the description of holding beliefs that are considered radical to show that predicting terrorist violence on the basis of holding such beliefs may not necessarily prove correct (BBC News, 'Profile: Antony Garcia', April 2007: Accessed at [http://news.bbc.co.uk/2/hi/uk\\_news/6149798.stm](http://news.bbc.co.uk/2/hi/uk_news/6149798.stm) on 4/6/17). In the second example, Schmid shows that despite Salafist Islamic teachings being blamed for terrorism in the world, the Brixton Salafi community had created and operationalized some of the most effective anti-terrorist initiatives in Britain that predated the government's own PREVENT programme. He further argues that the greater number of Muslims in Western countries consider it immoral and counterproductive to engage in terrorist activities. The scholar elaborates that it is only a minuscule fringe group of Muslims that is involved in

‘takfiri’ (which refers to those Moslems who consider it justifiable to kill other people as unbelievers or ‘kafir’ using any means available to them).

#### **4.0. Conceptualizing Radicalization**

Given the varying definitions of the term radicalization in the terrorism discourse, one is tempted to ask: what is radicalization? And is there anything wrong with an individual becoming radical, a derivative of radicalization? Some scholars have questioned the basis on which Western governments have framed the term radicalization to facilitate securitization of people or communities that these governments define as being vulnerable to radicalization. Looking at the original meaning of a radical, it referred to an individual with radical or different opinions and ideas about some situation. According to the Oxford English Dictionary, being radical is ‘advocating far-reaching political or social reform; representing or supporting an extreme section of the party’ (OED Online 2014a). Based on this argument, Baker-Beall et al (2015), posit that there is nothing really wrong with one being radical given historical examples of people who held radical beliefs on particular issues but were later vindicated by laws passed to support their arguments. The civil rights movement in the United States early in the twentieth century is a good example of this and others.

The emphasis on the ‘vulnerable individual’ that Western governments have highlighted as the focal point for securitization in efforts to deal with the menace, is further questioned on grounds that it had avoided to pay close attention to the study of Al-Qaeda as an international terrorist organization (Githens-Mazer and Lambert, 2017). To test whether the vulnerable narrative really works in all radicalization cases, the two scholars interviewed three Moslem brothers originally from Algeria who went through what fits the typical radicalization cycle, exposure to jihadist videos and Salafist teachings/indoctrinations and talks by jihadist recruiters on how Moslems were being mistreated by corrupt Moslem governments in Algeria, Egypt, Tunisia, Saudi Arabia and others. Their findings showed that only one of the brothers was in the end actually radicalized to the point of preparing to carry out terrorist bombings. This in itself shows that despite all the three brothers going through circumstances and environments that exposed them to jihadist indoctrination, they did not all become actual terrorists even though they might have sympathized with Islamicist causes because of their

indoctrination.

### **5.0. Lone-Actor Terrorists**

This term refers to terrorists who carry out terror attacks seemingly on their own without overt control by any particular terrorist group (van Zuijdewijn and Bakker, 2016). Some scholars have theorized that these types of terrorists could be acting the way they do as a result of radicalization through propaganda and being sympathetic to certain religious or cultural and political convictions as in the case of right-wing terrorists. Research by Countering Lone-Actor Terrorism Project (CLAT) led by Zuijdewijn and Bakker, had shown that about 35% of perpetrators of terror acts suffered from some mental disorder which could be as a result of social isolation suggesting a relationship between mental disorder and social isolation as a trigger for violence. The findings of the CLAT project lend support to the Queen Mary University own findings suggesting a similar relationship. However, the issue of why certain people seemed not to be influenced to the extent of performing terror acts as found by Schmid and others despite their possessing similar traits, is an issue that needs further investigation to clarify why that was the case.

### **6.0. Kenyan Perspective on Terrorist Recruitment**

In the past decade, Kenya has been the target of the Al-Shabaab terror group based in Somalia, which pledged allegiance to al-Qaeda in 2012. Al-Shabaabis said to cooperate with the older radical group in training in infantry tactics, indoctrination and use of explosives. The group advocates the Wahhabi form of Islam originating from Saudi Arabia which is also the version embraced by al-Qaeda and ISIS terror groups as opposed to Sufism for the typical Somalis (Blanchard, 2007; Armanios, 2003). As argued above, only fringe groups of those that embrace the Salafist version of Islam demand application of the strict adherence to Sharia laws that requires among other things, the stoning to death of any woman accused of adultery and the amputating of the hands of alleged thieves. Wahhabism is a form of Sunni Islam practiced in Saudi Arabia and Qatar. (Counter Extremism Project, 2004; Blanchard, 2007).

The al-Shabaab terror group has been most active in Somalia where it had gained a strong foothold as the youth wing of the Union of Islamic Courts which controlled Mogadishu in 2006. It had entrenched itself in Somalia to the point where it was engaged in all manner

of illicit trade and business including sea piracy and charcoal business. In 2010 and 2013, the group launched spectacular attacks in Kampala, Uganda and Westgate, Nairobi, Kenya, respectively. The Westgate attack and others in various locations in the country, strengthened the Kenya Government's resolve in its decision of deploying military forces codenamed Operation Linda Inchi, (Swahili for Defend the Country) from the Kenya Defence Forces (KDF) to Somalia on 26<sup>th</sup> October 2011. The KDF forces had deployed alongside other forces from four other African Union member countries, Uganda, Rwanda, Djibouti, Sierra Leone and Burundi, aimed at routing out the problem from its source and preventing and averting further attacks.

While the deployment of troops in Somalia by Kenya Government has gone a long way in curtailing and stopping crime and illicit business and brought much of the southern parts of the country to near normalcy, the terrorism threat is still much evident in Kenya as well as in Somalia itself. Al-Shabaab has been carrying out bombings of key government installations in Somalia and has sporadically used road-side bombs, improvised-explosives-devices (IEDs) and mined roads targeting Kenyan Government official vehicles as they ferried important government personalities to official functions particularly in northern and coastal areas of Kenya.

By many accounts, the majority of al-Shabaab operatives are young boys in their early twenties who joined the group at between the ages of 10-24 (Botha, 2014: Radicalisation in Kenya: recruitment to al-Shabaab and the Mombasa Republican Council). In her quite extensive research on the two terrorist groups operating in the coastal and north-eastern parts of Kenya, Botha collected data showing that 57% of al-Shabaab respondents interviewed claimed to have joined the group at ages 10 and 24 compared to MRC recruits at 53% for the same age group. The researcher further considered other factors such as who introduced operatives to al-Shabaab and MRC recruiters and the level of education of the recruits. The analysis of data collected suggests that the majority of al-Shabaab recruits, 66%, were introduced to radicalization by friends while only 38% of MRC recruits were similarly introduced.

Other factors that are utilized in recruitment included a religious figure playing a recruitment role which in respect of al-Shabaab was 34% and MRC at 38%. For the two groups, the level of education of the majority of recruits seems to have played a

significant role in their joining terrorism and extremism activities. For al-Shabaab, the great majority, at 67%, had received only primary school education while MRC was at 47%; those who had attained secondary education for al-Shabaab were 45% and MRC 24%, and lastly, those with tertiary education or better stood at 8% for al-Shabaab and 9% for MRC.

Botha has gone on to suggest, without offering supporting evidence, that the Kenya Government had deliberately denied the north-eastern and coastal people, who are mostly Moslems, development and economic opportunities in favour of up-country Christian citizens. Her findings suggest that those with minimal education were most at risk of recruitment due mostly to economic reasons but also due to their narrow world views. This view is, however, not supported by empirical research carried out by Rink and Sharma (2016) in Eastleigh area of Nairobi. The two researchers suggest instead that al-Shabaab has utilized the historical Christian-Moslem tensions in Kenya in order to entice potential recruits to its ranks and to justify violence.

Lack of a good education, some researchers have argued, is among the factors that can lead to failure or an inability to secure better economic opportunities, which has a relationship with the susceptibility of some youth being at a greater risk of radicalization into extremism. The relationship was due to factors such as poverty, feelings of alienation from the society they currently live in especially in countries like Britain, perception that Western governments treated Moslems unfairly and often targets them for attack and punishment, perceptions that in Kenya, people from the interior parts of the country were favoured by the authorities or government in employment and other opportunities as compared to Moslem-faith people (Nafeez Ahmed, 24<sup>th</sup> May 2017; Kundnani, 2014; Botha, 2014).

## **7.0 Conclusion**

For this article the recent Manchester City bombing was used as an opening of the debate to highlight how the youth can become indoctrinated into extremism. The discussion has shown that parents play critical roles in the shaping of their children's worldviews as exemplified by the Ramadan family's involvement into terrorism in Libya to topple the Gaddafi regime. Additionally, it shows that neighbourhoods where a person spent his or her formative years also play a critical role in the shaping of the behaviors of young

people. We also saw that being the father figure, Ramadan, Abedi's own father introduced and encouraged his sons to participate in terror activities against the Gaddafi government, a behavior that shaped the sons own futurebehaviour to view violence and murder against perceived enemies of Islam as normal.

The results of interviews conducted by Githens-Mazer about two Moslem brothers who were exposed to radicalization and extremist teachings/videos,however, showed that only one of the brothers eventually progressed to the point of preparing to carry out bombings and other terrorist acts. This suggests that people can become radicalized through exposure to extremist indoctrination yet not reach a point of carrying out terror acts. What is lacking in this case of the two Algerian brothers who it turned out, only one of them went to involve himself in terror activities? In the case of Abedi, the father seems to have played the key role of enticing him into terrorism which might be speculated that a father figure is what is lacking in this other case.

Instead of focusing on alleged vulnerability of people, some scholars have proposed that for meaningful debate and subsequent research on terrorism to make headway, there was need to look at the political angle and policies of Western governments with a view of addressing what many Moslems perceive as meddling in Moslem countries.

In the Kenyan context, the results of data analysis by Botha shows that majority of youth joining the terror group do not have secondary education and that there were many non-Somali Kenyans attracted to the terror group. The conclusion, she asserts, is that it is an indication that the group would like to utilize them in internal operations inside Kenya where they can blend unnoticeably to the security forces.

As a way of addressing the al-Shabaab menace and other similar crime gangs and vigilantes in Kenya and other East African countries, governments need to craft opportunities for employment and self-employment that can alleviate the hardships that entice youth to join terror groups. The 'Jua Kali' economic model prevalent in many African countries can form a basis for a wider reaching self-employment scheme that addresses both unemployment while at the same time is a product innovation incubator for the youth that can manufacture products of high quality for the market.

We finally briefly looked at the lone actor terrorist and the kinds of influences that were behind their terror acts which were shown by the CLAT project to be partly as a result of

mental breakdown.

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# **Sub-Theme: Innovative Approaches to Education and Training for Sustainable Development**

**The Need for Ict in Adult Education for Socio-Economic Development in Maiduguri, Borno State, Nigeria**

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## **ABSTRACT**

The thrust of the study was to examine the need of ICT in Adult Education for socio-economic development in Maiduguri, Borno state. In this light, the study adopted questionnaire method for data collection, simple frequency distribution and percentage rate were used to analyse the collected data from schools. The study investigated the level of introduction of ICT in Adult education and its benefits to individuals and societies for socio-economic development. The study revealed that the use and introduction of ICT in adult education is less but it was ascertained that ICT contributes a lot in human endeavors. The study suggested that there is need for adult educators and special education specialists to collaborate to develop ICT literacy primers, e-learning and distance education programmes, assistive technology and therapy services for adults within the community. This will enable learning take place in the life of these individuals, ICT integration to adult education should be emphasised, fully recognized and have affordable physical structures, facilities and resource materials readily available to most adult education centres in Maiduguri, the adults should be sensitized on the need of adult education for socio-economic development and not just to promote their salary scheme in their place of work as this study revealed and finally, there is need for an uninterrupted electricity / power supply situation in Nigeria so that there will be opportunities for

significant improvements and increase in ICT awareness among the rural and urban dwellers.

**Keywords:** ICT, Adult, Education, Socio-Economic, Development, Maiduguri

## **Introduction**

The supposed target of every nation is to make life easy, cheap and comfortable for her citizens. It is the intention that drives nations into embarking on many activities some of which are economic, political, social, religious, cultural, technological, etc., in order to raise the capital base of the nation. It is believed that increase in capital base will empower the nation to embark on development of infrastructure and production of goods and services that would make life easy, and comfortable. In an ideal society, comfort as a result of improved human well-being is achieved when there are; an increase in capital income, Gross Domestic Product (GDP), Gross National Product (GNP), shift from primary to secondary production, reduced dependence on importation, strong industrial capacity, increased literacy level etc. In Nigeria, the case is different. Attempts to grow Nigerian economy has been disturb by poor infrastructural facility development and maintenance, dependence on imported goods and services, reliance on a single economic sector, weak industrial capacity, inefficient and ineffective public utilities, low literacy level which constituted a cog in the wheel of Nigerian's economy, and has hindered human growth and development. Result of this calls for Adult Education programmes to caution those factors that are negatively contributing to socio-economic growth.

Adult education is expected to address the socio-economic, cultural, political and environmental problems besieging humanity in their various societies. This is so because adults are the major occupants of the production sectors of the economy. Fasakun (2006) observed that adult education is not concerned with preparing people for life but rather with helping or assisting people (adults) to live more successfully as useful and acceptable members of their societies and contribute meaningfully to the development of those societies.

Obi Omemagwa (2012), also emphasizes that adult education programmes unlike education for children and adolescents, center on the immediate needs and problems of the adults in their homes, social and occupational roles, civil and economic interest and therefore they have immediate direct positive relationship with development efforts, there is need to

develop a skilled and informed population of adults who would be capable of understanding national problems and needs and are able to channel their activities towards the fulfillment of national goals. Skilled and informed adult populace is very necessary both for the advancement of social and economic development as well as the promotion of internal unity. These facts make adult education an indispensable means for the achievement of economic, political and social survival.

Nnazor A.A and Aboh R.T. (2015) stresses that adult education encompasses all education and training activities undertaken by adults for professional or personal reasons. According to them, it includes general vocational and enterprise based training within a lifelong perspective.

Barikor (2012) defined adult education as any form of educative experience engaged in by people who are chronologically mature, socially responsible and mentally alert or deficient but eager to meet their specific needs. These may include intellectual need, occupational skills, socio-economic responsibilities, professional competencies and even self-fulfillment or self-actualizing needs, to improve themselves, by developing their knowledge, insights, tastes, attitudes and skills.

Anyanwu, (2014), also stated that adult education is very vital for addressing these problems because it provides adult with the necessary skills, attitudes, knowledge, values, beliefs required to trigger social and economic development of any society. It is important to target adults because they, rather than children hold the destiny of modern society in their hands.

He further maintains that adults are those who are already working and participating in development efforts. For so, their efforts as a class working citizens are more of societal development if properly oriented with the use of Information and Communication Technology (ICT) which facilitate access to productive information.

As can be seen from the information above, adult education should be re-positioned to excessively launch the present adults into the orbit where they can respond to the challenges brought in by technology in order to make meaningful contributions to national development. Nzeneri (2010) clearly stated that:

“Our 21<sup>st</sup> century is characterised by an upsurge of information technology which dictates the pace of development and surely we have not stopped talking about technological transfer. A century where communication and infrastructural facilities such as telephones,

fax and computer networking are tools that are turning our world into a global village, where classroom may no longer play prominent roles as major access to education.

ICT refers to technologies that provide access to information through telecommunications. In other words it is the use of technologies that help people or businesses use information. ICT makes it possible to store, transmit, retrieve, manipulate, or receive data electronically. The devices include: mobile phones, wireless networks, TV etc.

ICT makes communication between one party and another faster and easier. In recent times ICT has made constant communication a part of everyday life even among adults. It provides the society with a vast array of new communication capabilities in such ways that people can communicate in real time with others, send instant messages, social networking, internet services, and websites accesses like Facebook even when users are nowhere near to each other. Therefore, it allows the user to store, retrieve, transmit, share and receive information as the needs arise.

Internet has been beneficial in mobilizing people globally at the grassroots to take a common stand on global issues of common concerns. Igbo (2008) observes that adult education is an instrument for helping the active population worldwide with information and communication technology, which is a decisive tool for the smooth integration of Nigerian economy in the global economy. ICT definition at this point becomes necessary to make this discussion intelligent and clearly identify the challenges and prospects of integrating ICT into adult education in Nigeria. Onyekwe (2006) saw ICT as a broad based electronic technology that is used for collecting, storing, processing and transmitting information in various forms. ICT is, therefore, technology that generally supports the individual's ability to manage and communicate information electronically.

The relevance of ICT in adult education cannot be overemphasized. This is because the world has become a global village where every of human activities are computerized. This implies that the applicability of the computer system and other technologies to the affairs and administration of the educational sector in Nigeria would be of great benefits to its human resources development and productivity. The rate of changes brought about by the introduction of technologies has had a significant effect on the way people live, work and play as well as the way education is managed. It is applied in all spheres of education curriculum.

Rev. Canon Chris N. & Prof. G.A. Ike, (2015) pointed out some of the areas in which ICT may be of relevance to education especially on adult education included:

- **Access to variety of learning resources:** ICT helps in a great way in accessing plenty of resources to enhance teaching skills and learning ability (Owolabi, Oyewole and Oke, 2013). ICT has helped in the provision of audio visual education. It learners are encouraged to regard computers as tools to be used in all aspects of their studies. They make use of the new multimedia technologies to communicate ideas, describe projects and other information in their work.

- **Immediacy of information:** In this time of computers and web networks the rate by which knowledge is imparted is very fast which also enhances education anywhere at any time. Information and data desired for any study are obtained at will and when needed.

- **Anytime learning:** ICT aids one to study whenever he/she wills irrespective of whether it is day or night and whether the teacher is available or not.

- **Multimedia approach to education:** These are audio-visual education, planning, preparation and use of devices and materials that involve sight, sound or both for educational purposes.

These include; TV, audio tapes, records, computers, video discs. Information taken through multimedia are received simultaneously either by vision or hearing or both.

- **Distance learning:** This enhances learning at a distance rather in a classroom. This replaces the home study, external study or correspondence study by mail of old. This type reduces costs per student. They save by studying at home on time and travel and other costs. It appeals to students who prefer learning at home.

Kozma (2005) also noted that the benefits of ICT in adult education are that ICT can:

1. Offer opportunities for more adult-learner-centred teaching. There is a common belief that the use of ICT in adult education will contribute to more constructivist learning and an increase in activity and greater responsibility of the adult learner (Volman, 2005).

2. Provide the adult educator with new sources of information and knowledge which will enhance the process of and practices of teaching adults. This is because acquisition of ICT knowledge and skills can help the adult educators to obtain basic knowledge of principles of teaching and learning and the skills to apply those principles in teaching – learning situations.

3. Provide adult learners the opportunity for distance learning country-wide with on-line educational materials even in the face of their tight schedule of activities.
4. Help in providing adult-learners with additional resources to assist resource-based learning e.g., the fax, telephone, computers, e-mail, internet, WWW (World Wide Web) etc.
5. Broaden access to quality educational services for adults at all levels of adult education.
6. Help in producing ICT literate adults who will be useful to themselves and contribute meaningfully to the society in which they belong.
7. Produce adults who are capable of working and participating in the new economies and societies arising from ICT and related development.
8. Help education policy makers in formulating and execution of educational policies which will be inclusive in nature to bridge the gap in education.
9. Widen the range of opportunities for the marginalized and the disadvantaged members in the society by opening access to knowledge.
10. Encourage self-directed learning because adults can engage in personal learning by using their personal computers or internet connection.
11. Help adult learners to have access to tutorial software.
12. Help in improving the effectiveness and efficiency in adult education system in Nigeria as a whole.

In addition, adult learners can use ICT in business transactions and other human endeavours activities that require ICT for their accomplishment and achievement of goals.

Thus, for adults not to be left out in what is happening in the world they are to key in into the use and application of this technology and this can only be achieved through the integration of ICT into adult education in Nigeria.

### **Brief History of Maiduguri**

Maiduguri, also called Yerwa by its locals, [citation needed] is the capital and the largest city of Borno State in north-eastern Nigeria. It is popularly called "Home of Peace". The city sits along the seasonal Ngadda River which disappears into the Firki swamps in the areas around Lake Chad. Maiduguri was founded in 1907 as a military outpost by the British and has since grown rapidly with a population exceeding 1 million by 2007. The region was home to the Kanem-Bornu Empire for centuries. Maiduguri actually consists of two cities: Yerwa to the West and Old Maiduguri to the east. Old Maiduguri was

selected by the British as their military headquarters while Yerwa was selected at approximately the same time by Shehu Abubakar Garbai of Borno to replace Kukawa as the new traditional capital of the Kanuri people. Maiduguri is estimated to have a population of 1,197,497 by 2009 as of 2007. Its residents are mostly Muslim including Kanuri, Hausa, Shuwa, Bura, Marghi, and Fulani ethnic groups. There is also a considerable Christian population.

Maiduguri is home to three markets which include an ultra modern "Monday market" that has a spectacular satellite image view. There is an ancient museum and is served by the Maiduguri International Airport. The city has one of the best layouts in Nigeria. The values of land and properties are expensive in Maiduguri. A survey of property markets in Nigeria (2009) positioned Maiduguri as the third most expensive for buying and renting in the country next to Abuja and Lagos. Maiduguri is the principal trading hub for northeastern Nigeria.

Its economy is largely based on services and trade with a small share of manufacturing. The city lies at the end of a railway line connecting Port Harcourt, Enugu, Kafanchan, Kuru, Bauchi, and finally Maiduguri.

Maiduguri has one of the best-equipped universities and hospitals in Nigeria. The University of Maiduguri attracts foreign students from neighboring countries especially Cameroun and Niger Republic. The College of medical sciences is amongst the top 5 best medical schools in Nigeria. Other higher institutions include Ramat polytechnic, College of agriculture and College of education.

As of 2011, the Future Prowess Islamic School provided a free Western and Islamic education to orphans and vulnerable children, was open to both boys and girls, and was free of charge.

Since the mid-1960s, Maiduguri has witnessed outbreaks of large inter-religious riots. Members of religious sects led intercommunal violence in 1982 and 2001.

On 18 February 2006, riots related to the Muhammad cartoons published by the Danish newspaper Jyllands-Posten left at least 15 people dead, and resulted in the destruction of

approximately 12 churches. Soldiers and police quelled the riots, and the government temporarily imposed a curfew.

In 2002, a Muslim cleric named Mohammed Yusuf founded the Islamist group Boko Haram in Maiduguri, establishing a mosque and an Islamic school that attracted children from poor Muslim families from both Nigeria and neighboring countries. In July 2009, Maiduguri was the scene of major religious violence throughout Northeast Nigeria committed by Boko Haram, which left over 700 people dead.

On May 14, 2013, President Goodluck Jonathan declared a state of emergency in Northeast Nigeria, including Borno State, due to the militant activity of Boko Haram. The entire city was under overnight curfew, and trucks have been prevented from entering the city and the social, economic and political activities came under comatose. Twelve areas of the city that are known to be strongholds of Boko Haram are under permanent curfew. On 18 June 2013, Boko Haram militants attacked a school as students were taking an exam; nine students were killed.

On January 10, 2015, a bomb attack was executed at the Monday Market in Maiduguri, killing 19 people. The city is considered to be at the heart of the Boko Haram insurgency. In the early hours of 25 January, Boko Haram launched a major assault on the city. On January 26, CNN reported that the attack on Maiduguri by "hundreds of gunmen" had been repelled, but the nearby town of Monguno was captured by Boko Haram. The Nigerian Army claimed to have successfully repelled another attack on Maiduguri on January 31, 2015. On February 17, 2015, Monguno subsequently fell to the Nigerian military in a coordinated air and ground assault. On 7 March 2015, five suicide bomb blasts left 54 dead and 143 wounded. On May 30, 2015, Boko Haram launched another attack on the city, killing thirteen people and many more cases of that in the recent time, though there is a relative peace now in the region.

### **Statement of the Problem**

Hall Marchel (2014) sees development as a steady overall economic growth of a nation together with the steady reduction of gap between the rich and the poor. He stressed that

without the concept of equitable distribution of national wealth, economic expansion can only be called growth, and not development.

Orubite (2013) understands development as “change in a desirable direction and encompassing many different dimensions”. Economic, social and political developments are part of the dimensions of development from which the concept “socio-economic” was coined. Igbo (2008) observed that adult education is an instrument for helping the active population worldwide with information, which is a decisive tool for the smooth integration of Nigerian economy in the global economy.

Dabesaki (2005) noted that this revolutionary trend is not widespread and needs to be strengthened to reach a large percentage of the population regardless of age or socio-economic background. Kinuttia (2008) stressed that adult education programmes have usually been carried out via radio, television, satellite and instructor-led lessons, but more recently some organizations have incorporated newer technologies.

Information and Communication Technology (ICT) is having a revolutionary impact on educational methodology globally (Dabesaki, 2005).

There is a need for ICT development and training to boost the manpower general workforce development, improve the people’s wellbeing and sustain the economy. As a result, many governments, private and non-governmental institutions in Nigeria are striving to assist in the provision of ICT training programmes at all levels including work environments. The call for ICT policies in Nigeria is to allow individual citizens, including adults’ access the training and services connected to ICT because technological development may be a pipe dream for the country. In the light of this, the government set up the Nigerian National ICT for Development (ICT4D) strategic action plan committee to develop a new ICT policy for development and for all education sectors, including adult education sector.

### **Purpose of the Study**

The main purpose of this research is to critically investigate the need for ICT in Adult Education for socio-economic development in Maiduguri, Borno State of Nigeria. Other objectives include; ascertaining the level of introduction of ICT in Adult Education; to determine the level of use of ICT by the Educators; to ascertain the availability of ICT and related facilities/outfits, to find out possible problems mitigating the use of ICT in Adult Education with a view to proffer solutions.

## **Objectives of the Study**

The objective of this study is to determine the usefulness of ICT in Adult education and how much it helps or contributes to the development of socio-economic development in a community, society or country at large and also to checkmate some of the challenges of ICT in Adult Education.

Therefore prior to this phenomenon, there are some challenges of ICT on adult education for socio-economic development in Nigeria, they are:

1. Introduction of ICT in Adult Education.
2. The availability of ICT facilities.
3. Competency of the educators.
4. The conduciveness of the ICT environment for learning.
5. The impact of ICT in Adult Education for socio-economic development.
6. The impact of networked ICT on literacy learning.

## **Significance of the Study**

It has been noted earlier that humans especially adults hold the destiny of any nation in their hands because they are those who are already working and participating in developmental efforts. Adults have been considered both as assets and capital for productive efforts. It is therefore necessary to develop them for they are the procedures, contributors and protectors of economic growth.

This view makes it necessary to have a sound adult education programmes for the development of literate, informed, skilled and competent adult population for a meaningful socio-economic development.

## **Research Questions**

The following research questions will be considered:

1. Is ICT introduced in Adult Education?
2. Do you have good number ICT facilities?
3. Is the use of ICT conducive for learning?
4. Does ICT contribute positively to the society?
5. Do the Educators use ICT facilities for teaching and learning?

## **Methodology**

The design for this study is evaluative and descriptive. The population for the study used for the survey consisted of all adult students in Maiduguri. The sample size of 150 was randomly selected.

A self-designed questionnaire was used to collect the data for the study. The questionnaire was administered by the researcher in the area of the study. Personal contacts of the researcher with the respondents enhanced good and prompt response from the respondents. Data collected were analysed using frequency counts and percentage scores.

### **Result/ Discussion**

**The key to alternative options lettered AG, NG and ND reflected in the options column on the Table below is AG = Agreed, NG = Not Agreed and ND = Not Decided**

The results of the data presented and analysed in the Table below is discussed in relation to the research question.

#### **The use and relevance of ICT by all respondents**

Responses to items 2, 3, 4, 5 and 8, acknowledges that the use of ICT improves learning, provides opportunity for distance learning country-wide with online educational materials, helps to get more information easily, contribute meaningfully to the society and necessary in most of the activities and human endeavors, even though response to item 6 suggests that the educators do not use ICT facilities in the teaching and learning process which may be due to lack of trained computer staff or incompetency among the educators or as a result of lack of ICT facilities as item 9 suggests.

#### **The Use and Availability of ICT facilities**

It can be observed from the responses to item number 1 and 9 that majority of the respondents disagreed to the statement “ICT is used in Adult Education” and lack of ICT facilities for teaching and learning respectively.

#### **Other purposes for which Adults Enroll in Adult Education**

Based on the analyzed data shown in the Table below, response to items number 7 acknowledges that Adult Education is an important programme to the society, but seems to be more important to Adults in promoting their salary structure as observed in item 10 in the table above. Barikor (2012) defines adult education as: any form of educative experience engaged in by people who are chronologically mature, socially responsible and mentally alert or deficient but eager to meet their specific needs. These may include intellectual need,

occupational skills, socio-economic responsibilities, professional competencies and even self-fulfillment or self-actualizing needs, to improve themselves, by developing their knowledge, insights, tastes, attitudes and skills.

### **Conclusion**

From the foregoing, it is evident that ICT empowers citizens to continuously adapt to community, national and global developmental challenges, as well as to develop the required knowledge, skills associated with life-long learning and community development. This is, therefore, a challenge to literacy, and special education instructors in Nigeria. There is need for the appropriate integration of ICT in adult education settings to enhance the capacity of both adult educators and adult learners to become more responsive to new challenges in ICT. Integrating ICT in adult education programmes would provide everyone with basic skills and to use such new technologies during development training, workshop, seminars, conference, teaching and learning environment.

### **Recommendation**

1. There is need for adult educators and special education specialists to collaborate to develop ICT literacy primers, e-learning and distance education programmes, assistive technology and therapy services for adults and exceptional individuals within the community. This will enable learning take place in the life of these individuals.
2. ICT integration to adult education should be emphasised, fully recognized and have affordable physical structures, facilities and resource materials readily available to most adult education centres in Nigeria.
3. There is need for the government to increase the electricity / power supply situation in Nigeria so that there will be opportunities for significant improvements and increase in ICT awareness among the rural and urban dwellers.
4. Adult educators should be trained on the use of ICT facilities and assistive technology. This will help individual adults and the exceptional adults benefit from such training.
5. ICT policies in the country should be enforced by the government through her agencies like the National Information and Technology Development, especially as it concerns the adult education sector. The agency should collaborate with different

government agencies to develop and promote public-private partnership for integration of ICT into adult education programmes in Nigeria.

6. Emphasis should be laid to the learning contents to reflect the needs of the adults in the communities.
7. Government should establish National ICT education, training and awareness initiative to promote ICT awareness literacy, adult and non-formal education in the country.
8. There is the need to orient the adults to know that the socio-economic development of any nation or community lies in their hands and therefore, take adult education beyond the scope of studying to upgrade their salary but also to contribute meaningfully to the growth and development of a nation and the well being of their people.

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**Table**

Total number of 150 questionnaires was administered and 138 questionnaires were retrieved.

S/n	Items	Opt	Freq	%	Response/Interpretation
1	ICT is used in Adult Education in Maiduguri	AG NG ND	36 95 7	26.1 68.8 5.1	26.1% of the respondents agreed that ICT is used in adult education, 68.8% disagreed and 5.1% have not decided
2	ICT improves learning	AG NG ND	99 28 11	71.7 20.3 8	71.7% of respondents agreed that ICT improves learning, 20.3% disagreed and 8% have not decided
3	ICT provides opportunity for distance learning country-wide with online educational materials	AG NG ND	84 39 15	60.9 28.2 10.9	60.9% of the respondents agreed that ICT provides opportunity for distance learning country-wide, 28.2% disagreed and 10.9% have not decided.
4	The use of Internet helps to get more information easily	AG NG ND	123 15 0	89.1 10.9 0	89.1% of the respondents agreed that the use of Internet helps to get more information easily and 10.9% disagreed.
5	ICT literate adults contribute meaningfully to the society he belongs to	AG NG ND	112 23 3	81.2 2 16.7	81.2% of the respondents agreed that ICT literate adults contribute meaningfully to the society he belongs to, 2% disagreed and 16.7% have not decided.
6	Educators use ICT in the teaching and learning process	AG NG ND	37 101 0	26.8 73.2 0	26.8% of the respondent agreed that educators use ICT in teaching and learning process and 73.2% disagreed.
7	Adult Education is an important programme to the society	AG NG ND	84 40 14	60.9 29 10.1	60.9% of the respondents agreed that Adult Education is an important programme to the society, 29% disagreed and 10.1% have not decided.
8	Most of the activities and human resources are ICT based	AG	119	86.2	86.2% of the respondent agreed that most of the activities and human resources are ICT based

	endeavors in life need ICT.	<b>NG</b>	17	12.3	activities and human endeavours in life need
		<b>ND</b>	2	1.4	12.3% disagreed and 1.4% have not decided.
9	There is reasonable number of ICT facilities used for learning.	<b>AG</b>	43	31.2	31.2% of the respondent agreed and 60.8% disagreed
		<b>NG</b>	84	60.8	that there are no sufficient ICT facilities and 1.4% have not decided
		<b>ND</b>	11	8	
10	I need Adult Education for promotion at work place only.	<b>AG</b>	99	71.7	71.7% of the respondents agreed that they need Adult Education for promotion at work place.
		<b>NG</b>	39	28.3	
		<b>ND</b>	0		

**Impact of Supervision on the Management of Secondary School in Maiduguri  
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**ABSTRACT**

This study was designed to evaluate the impact of supervision on the management of secondary schools in Maiduguri metropolitan council Borno State. The designed objectives were to determine the impact of supervision on the management of instructional work, school records, school environment, school and community, school funding, and staff development. These were properly achieved by descriptive research method. Data were collected with the use of questionnaire. A total of 202 Supervisors and teachers responded to the questionnaire, the data were analysed and interpreted through the use of t-test statistics. There was hypothesis testing where  $p > 0.05$ , means that any t – value that is below 0.05 was rejected. The research discovered that there is need for more provision of facilities for teaching and learning; record keeping need to be improved. There is need for constant supervision of instructional work. This helps in meeting the desired aims and objectives of primary school education. It is recommended that workshops and conferences on the importance of school supervision should be held from time to time to teachers and school administrators in order to meet the new millennium trends in education.

**Keywords:** Impact, Supervision, management and secondary schools.

**INTRODUCTION**

Education is growing more prominence in the affair of Nigerians than ever before. It is seen as a way of answering so many questions and solving a myriad of problems, more

funds are been committed into education by both the Government and private sectors. There is therefore a greater demand for probity and accountability. The maintenance of standards and assurance of adequate measure of quality control are now the concern of all parents, therefore the significance of school supervision has now come into lime light.

The sudden explosion of student's population coupled with the attendant increase complexity of school organization and introduction of school new basic system of 6-3-3-4 or 9-3-4 system of education in the country has indeed necessitated a greater attention of supervision more than ever before. This is more so because school supervision occupied a unique place in the entire educational system. If quality education is, a thing seriously desired in schools so that standard of education in our schools will be tightly improved, school supervision must therefore be accorded with high priority. Through supervision, supervisors assist in improving classroom instruction and made teachers more competent and efficient.

School supervisors do not only monitor teachers but also give them chance to discuss their problems and provide ways to handle them. In addition, it identifies those that are due for promotion or those that are supposed to go for studies, workshop and conferences. School supervision is very important for the benefit of both teachers and students.

Supervision is a way of stimulating, guiding, refreshing, encouraging teachers with the hope of achieving the educational set goals. Supervision is an age-long device for improving teachers' skills. Supervision deals with the basic needs of schools, and it help in provision, maintenance, assisting and proper placement of both human and non-human materials in schools.

Areas where supervisors assess in school include the resources (fund), environment, school and community development, records, staff development, and school instructional material. All these areas are vital which such schools will not remain as schools without them. Therefore, these are areas, which, if much attention is not given, the educational goals will not be achieved or realized. Thus, this research attempts to study if there is any impact of supervision on the management of these areas.

In whatever context, supervision is meant for improvement of work performance. Today, different people view supervision in different lens. In a broad sense (Pierce and

Rowell, 2005) define supervision as a developmental process designed to support and enhance the individual's motivation, autonomy, awareness, and skills necessary to effectively accomplish the job at hand.

Basically in education sector, the main purposes of supervision are to improve classroom instruction and to promote professional growth and development of teachers. Many scholars have defined the term Educational supervision in various ways because Supervision may be seen as a positive for program improvement.

Ghapanchi, Z. and Baradaran (2014) defined educational 'supervision' as the systematic application of principles of supervision in solving educational problems in order to get to a sustainable level of achievement. Kankam, G. (2014) opined that supervision is a helping relationship whereby the supervisor guides and assists the teachers to meet targets.

Supervision is a complex process that involves working with teachers and other educators in a collegial, collaborative relationship to enhance the quality of teaching and learning within the schools and that promotes the career long development of teachers (Beach &Reinhartz, 2000).Similarly, Glickman et al. (2004) shared the above idea as supervision denotes a common vision of what teaching and learning can and should be, developed collaboratively by formally designated supervisors, teachers, and other members of the school community.

A Supervisor is someone who over sees the performance and development of others (LondonDeanery2011). The dictionary of education (as cited in Kalule and Bouchamma 2013) provided the most extensive definition of supervision as all efforts of designated school official toward providing leadership to the teachers and other educational workers in the improvement of instruction; involves the stimulation of professional development of teachers, the selection of educational objectives, materials of instruction, and methods of teaching, and the evaluation of instruction.

In summary, the definitions of supervision highlighted above imply that the focus of supervision in a school is mainly related with providing professional assistance for teachers, the improvement of instruction and increasing of students' learning performance.

## RESEARCH QUESTION

What is the impact of supervision on the management secondary schools of Maiduguri Metropolitan Council?

## HYPOTHESIS

There is no significant difference in the opinions of supervisors and teachers toward impact of supervision on the management of Secondary schools of Maiduguri Metropolitan Council.

## METHODOLOGY

This type of research is descriptive in nature. The research design is a sample survey because it involves collection of information about the entire population, and collection of data from representative sample drawn from the entire population. According to Creswell, (2003) descriptive survey method is used to generate views and opinions of relatively large number of respondents and to indicate a clear picture of the situation. It is also a method that enables us to obtain pertinent and precise information. Also, Johnson and Christensen, (2012) opined that the focus of descriptive research is not to only look out for cause-and-effect relationships but rather, describes the existing variables in a given situation and, sometimes, the relationship that exist among those variables.

The population for this study comprises, Supervisors and teachers of the ten (10) randomly selected Secondary schools in Maiduguri Metropolitan Council. It was out of this target population that a respective sample (accessible population) was drawn for this study.

The total number of the Supervisors in the ten (10) selected primary schools is twenty (20), and teachers are nine hundred and ten (910). According to Mussaazi (1982) table to determine sample size of any population that is above five hundred, 20% is enough for sample size.

Table 3.2 shows summary of sampled population.

RESPONDENTS	POPULATION	SAMPLED
Supervisors	20	20

Teachers	910	182
Total	930	202

## INSTRUMENTATION OF DATA COLLECTION

For the purpose of this research work, the use of questionnaire was employed for data collection. Being a self-administered instrument, the respondents completed and returned the questionnaire through the research assistants who were trained for these purpose. This made the collection and collation of completed questionnaires easy.

The questionnaire were administered to teachers, and supervisors. The items in the questionnaires were centred on efficiency of school management, supervision of instructional works, school records, school/community development, school environment and school facilities, staff development, and school funding.

A five – point rating scale was used to measure, the subjects responses as Agree (A), strongly agree (SA), Disagree (D), Strongly Disagree (SD) and Undecided (UD)

The data collected from the field were subjected to statistical analysis for appropriate interpretations to achieve the set items and objectives of the study.

A t-test of independent statistical tool (SPSS 16) was used to analyse the set hypotheses.

## RESULTS

### Responses of supervisors and teachers on the impact of supervision on the management of secondary schools

S/N	Item stated	Respondent Categories	A		SA		D		SD		UD	
			F	%	F	%	F	%	F	%	F	%
1	Supervision of environment helps in maintaining neatness of the schools surrounding	Supervisors	12	60	6	30	1	5	1	5	-	-
		Teachers	66	37	44	24	50	28	15	8	5	3

<b>2</b>	Instructional supervision helps teacher to develop professionally	<b>Supervisors</b>	14	70	4	20	2	10	-	-	-	-
		<b>Teachers</b>	85	47	45	25	30	17	20	11	-	-
<b>3</b>	Historical, references, documentation and evaluation was gained due to supervision of school records in primary schools.	<b>Supervisors</b>	8	40	4	20	3	15	3	15	2	10
		<b>Teachers</b>	64	36	46	26	40	22	20	11	10	6
<b>4</b>	Supervision helps in the provision and maintenance of facilities successfully.	<b>Supervisors</b>	13	65	5	25	2	10	-	-	-	-
		<b>Teachers</b>	103	57	40	22	20	11	10	6	7	4
<b>5</b>	Supervision of community and school development serves its purposes	<b>Supervisors</b>	7	35	4	20	5	25	4	20	-	-
		<b>Teachers</b>	72	40	61	34	27	15	20	11	-	-
<b>6</b>	Supervision of staff development enhances the quality of	<b>Supervisors</b>	6	30	6	30	5	25	2	10	1	5
		<b>Teachers</b>	64	36	53	29	30	17	33	18	-	-

	teachers											
<b>7</b>	Teachers development and school expenditure were attained due to supervision of school funding	<b>Supervisors</b>	9	45	5	25	3	15	2	10	1	5
		<b>Teachers</b>	80	44	60	33	30	17	10	6	-	-
<b>8</b>	Teachers were giving chance to further their education when identified through supervision.	<b>Supervisors</b>	7	35	5	25	6	30	2	10	-	-
		<b>Teachers</b>	65	36	55	31	35	19	25	14	-	-
<b>9</b>	Records of test and examination serve their purpose in primary schools due to proper supervision	<b>Supervisors</b>	9	45	6	30	3	15	2	10	1	5
		<b>Teachers</b>	89	49	75	42	10	6	6	3	-	-
<b>10</b>	Using teaching aids is effective and efficient in schools due to proper supervision	<b>Supervisors</b>	6	30	6	30	5	25	2	10	1	5
		<b>Teachers</b>	86	48	56	31	30	11	10	6	8	4

Table above shows the responses of supervisors and teachers on the impact of Supervision on the management of secondary schools in Maiduguri Metropolitan Council.

Item one of table shows that 90% of supervisors and 61% of teachers are in support of statement Supervision of environment helps in maintaining neatness of the schools surrounding. Similarly, in item two 90% of supervisors and 72% of teachers all agreed with the statement Instructional supervision helps teacher to develop professionally. Also in item three which state that Historical, references, documentation and evaluation was gained due to supervision of school records in primary schools. 60% of supervisors and 62% of teachers all agreed with the statement. In item four, 90% of supervisors and 79% of teachers all agreed with the statement. With regard to Supervision of community and school development serves its purposes in item five, 55% of supervisors and 74% of teachers agreed with the statement. In item six, 60% of supervisors and 65% of teachers agreed with the statement Supervision of staff development enhances the quality of teachers.

In item seven, 70% of supervisors and 77% of teachers all agreed with the Statement Teachers development and school expenditure were attained due to supervision of school funding. In item eight, 60% of supervisors and 67% of teachers all agreed with the statement. In item nine which stated that Records of test and examination serve their purpose in secondary schools due to proper supervision, 75% of supervisors and 91% of teachers all agreed with the statement. Also in item ten, 60% of supervisors and 79% of teachers agreed with the statement using teaching aids is effective and efficient in schools due to proper supervision.

### **HYPOTHESIS**

There is no significant difference in supervisors and teachers on the impact of supervision on the management of secondary schools in Maiduguri Metropolitan Council.

#### **T-test showing there is no significance difference between supervisors and teachers**

CATEGORIES	N	MEAN	SD	SE	T	DF	P.VALUE
SUPERVISORS	20	26.9000	6.81253	1.52333	0.213	198	0.832
TEACHERS	180	26.6056	5.76592	0.42977	0.186	-	0.854

Table above shows that there is a slightly mean difference between the

supervisors and teachers. It is also observed that the p – value 0.832 is greater than 0.05 which mean there is no significant difference in supervisors and teachers on the impact of supervision on the management of primary schools. Therefore the null hypotheses is accepted.

## **DISCUSSION OF FINDINGS**

After interpretations of the data for this research, the findings of the study are summarized as follows.

- The study revealed that supervisions of instructional work is very necessary, because it involves the essential needs in teaching and learning aspect. It is what makes the school to be a school. It involves the class interaction activities between teachers and student such as subject matter, lesson delivery provision and usage of teaching aids, time management, class management, methods of teaching usage of lesson note, usage of chalk board, and the language communication skills in the class room and many more. All these are what make teaching to be teaching. It is a must for every teacher to know and make instructional work effectively and efficiently.
- The study also agreed that supervision of school records has a great impact in secondary school of Maiduguri Metropolitan council. According to the result, it shows that teachers and head teachers try their best in keeping of essential records in primary schools.
- The study agreed that there is impact of supervision as related to the provision and maintenance of school facilities. This means that due to supervision of school facilities the management of secondary schools in Maiduguri Metropolitan council; provide and maintained school facilities successfully.
- The study agreed that supervision of school environment in secondary schools of Maiduguri Metropolitan council, help in the minding the neatness of the school surroundings properly, the hygienic condition, the safety and security devices, where all been provided by the management adequately.

- The study agreed that supervision of school in secondary schools of Maiduguri Metropolitan council, provided a good relationship between the school and the community, where the school was located. It shows that, both of them work hand in hand towards the attainment of educational development.
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- The study agreed that supervision of school in secondary schools of Maiduguri Metropolitan Council provided a good relationship between the school and the community, where the school was located. It shows that, both of them work hand in hand towards the attainment of educational development.

### **CONCLUSION**

The study concluded that, supervision has impact on the management of secondary schools in Maiduguri Metropolitan Council. The questions have been answered and the analysed data showed that;

- Supervision of instructional materials has impact on the management of primary schools.
- Supervision has impact on the management of school records.
- Supervision has impact on the management of school environment
- Supervision has impact on the management of school and community relationship.
- Supervision has impact on the management staff development
- Supervision has impact on management of school funding.

The result of the stated hypotheses was retained. This means that supervision has impact on the management of secondary schools in Maiduguri Metropolitan of Borno State.

## **RECOMMENDATIONS**

The following recommendations were made based on the result of the findings of the research work;

- Workshops and conferences on supervision of instructional work should be provided for the teachers in order to have current knowledge that will help them to give their best for the new millennium trends in education.
- The supervisors should be having constant supervision in public schools. There is need for more provision of school facilities that will help in teaching and learning.
- There is need for more supervisory staff in Borno state especially in the secondary schools. Supervision of school environment should be punctual in order to help the management in finding out if there is any weakness regards to it. Because the surrounding stimulates the teachers terms of teaching and learning.
- The federal government should be adding more percentage to education budget instead of deduction. Education has many programs and procedures that generate money, the government should provide enough fund to educational sector.

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## **Harnessing Educational Technology to Stimulate Critical Thinking among Secondary School Learners for Sustainable Development in Kenya**

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### **ABSTRACT**

Critical thinking (CT) is an essential life skill that education should seek to equip learners with in order to actualize the attainment of Kenya's vision 2030 and the sustainable development goals (SDGS). Psychologists and philosophers argue that critical thinking provides individuals with the mental ability to think, inquire and interrogate phenomena in society which eliminates bias and blind acceptance of viewpoints. Individuals who are proficient in critical thinking are able to conduct strategic thinking, creative thinking and engage in appropriate decision making and problem-solving processes. Individuals empowered with these competencies are characterized with the ability to adjust to diverse demands of their environment. The outcome are individuals who are highly employable, adaptable and inquisitive with a knack to positively influence society with innovations and social reengineering of communities with ideas. There is apparent disconnect between the expected role of education in fostering critical thinking among learners in secondary schools in Kenya. Githui, Njoka and Mwenje (2017) established that the levels of critical thinking among secondary school learners in Nairobi and Nyeri Counties was disturbingly very low. The scenario implies that students' mental abilities hardly perform beyond mere memorization of facts and information. Learners critically lack the abilities to synthesize, analyze and evaluate information. Such students graduate from school deficient in the life skills necessary for effective living, work performance and inability to engage in activities of daily living in society. Unfortunately, educators in majority of learning institutions in Kenya lack an understanding of how educational technology can be harnessed to stimulate critical thinking skills during teaching and learning processes. This is despite the fact that critical thinking can be infused in pedagogy across all disciplines without occasioning expensive curriculum reviews. This study seeks to provide insights and information to educators and policy makers on how educational technology can be harnessed to stimulate critical thinking among learners during the teaching and learning process for sustainable development in Kenya.

**Objectives:** The study was guided by the following objectives, which were to;

- i. Discuss how to harness instructional resources to stimulate critical thinking during the teaching and learning process among learners for sustainable development in Kenya.
- ii. Assess how instructional techniques can be used to promote critical thinking among learners in secondary schools in Kenya.

iii. Evaluate how assessment techniques can be used in developing critical thinking among learners in secondary schools for sustainable development in Kenya.

**Methodology:** The study adopted the Social Cognitive Theory (SCT) propounded by Albert Bandura as its theoretical framework. The study relied on library review of secondary data and published reports regarding how to harness educational technology to stimulate critical thinking among secondary school learners in Kenya.

**Key words.** critical thinking, creative thinking, decision making, educational technology, inquisitiveness.

## **Introduction**

All over the world the ability to think critically has become an essential life skill to all individuals today. This has partly been informed by the rapid changes in technology, the globalization in economies, the expanding labour market and social changes. Healy (1990) stated that critical minds are increasingly gaining status as society's most valuable natural resource worthy of the effort and time needed to cultivate. In order to compete globally students must graduate from high school or college with the ability to problem solve and use critical thinking skills (Law & Kaufhold, 2009). Employers are looking for a work force that can think critically and produce results (Law & Kaufhold, 2009). Despite the importance of critical thinking as an educational outcome, Mendelman (2007) observes that the majority of schools miss to teach critical thinking to their students and as a result, the majority of the general public do not practice it at all. Arguing in the same vein, Hayes and Devitt (2008) observed that, critical thinking strategies are not extensively developed or practiced during primary and secondary education, given the emphasis on memorization and rote learning with a motivation that to attain high academic scores in national examinations. According to Peron (2010) the relationship between content and critical thinking presents a unique challenge to education. This is attributed to instructional requirements that place undue emphasis on mastery of core subject matter and stakeholder expectations of which make it difficult if not impossible to focus instruction on teaching critical thinking skills. In this regard, Matheny (2009) shared that majority of teachers in public schools have become so overly focused on their students attaining high grades in examinations that many sometimes end up teaching the test itself. Jenkins (2009) points out that when critical thinking skills are omitted from the educational process, society misses tremendous

benefits. In particular, students lack critical thinking skills inhibits in their' ability act appropriately to challenges they may encounter in new and unfamiliar situations that are helpful to intellectual development. In agreement to this view, Tsui (2002) noted that critical thinking skills challenge what is typically assumed by others and encourages learners to recognize the importance of different perspectives in problem solving. Indeed, Willingham (2009), observed that development of critical thinking skills improves content uptake and retrieval through the concept of meaningful learning. Matheny (2009) proposed that critical thinking skills and core content acquisition support each other adding that the idea of choosing between the two is a false dichotomy. Matheny further emphasized that instruction in critical thinking and core content are designed to be delivered simultaneously. McCollister and Sayler (2010) supported this notion, confirming that critical thinking can be infused in lessons throughout all disciplines by utilizing in depth questioning and evaluation of both data and sources. Having students track patterns in information stimulates them to look at the information as a process instead of simply information to be memorized and helps them develop skills of recognition and prediction. Evaluation of information helps students to learn appropriate procedures for utilizing credible information, as well as helping them to learn acceptable and appropriate ways to use discretion (McCollister&Sayler, 2010). These skills are helpful in reading, comprehension and problem-solving skills, all of which play an important role in standardized assessments (McCollister&Sayler, 2010). This deeper understanding allows the learners to better analyze the circumstances surrounding the occurrence and differing viewpoints about a phenomenon (Tsai, Chen, Chang & Chang, 2013).

Tsai, et al (2013) found that enhancing the critical thinking among students in science classes helped the students better understand the scientific process as well as encouraging students to become more experimental and inquisitive of the diverse facets of the sciences.

Knodt(2009)statedthatinnovativethinkingisenhancedwhenthe naturalinquisitiveness that studentsbringtothelearningprocessisinspired, affirmed,andcultivated.Whengiventheopportunitytoaskandexploreopenly,studentsacquirea

nd blossom. This opportunity must be provided by the educator if students are to learn to be critical thinkers rather than critics.

Opportunities must be provided for students to voice opinions and objections to topics rather than seek right or wrong answers. This brainstorming process is necessary to fuel the continuing curiosity of the learner. Content knowledge is best taught using natural curiosity because there is an innate desire within everyone to learn by challenging traditional thinking patterns (Healy, 1990). Critical thinking, higher order thinking, and problem solving make learning motivating, stimulating, and enjoyable (Jensen, 2005).

Choy and Cheah (2009) and Rowles, Morgan, Burns, and Merchant (2013) all found that teaching critical thinking skills can be enhanced by having a more standard definition of what critical thinking entails. This definition would allow educators at all grade levels to align the current curriculum with activities and lessons that help in cultivation of critical thinking among learners. In order to engage students in critical thinking, the teacher needs to act as a facilitator to give room for discussion and encourage a free thought process, as well as to encourage understanding that thinking critically does not always end with a right answer, but instead sometimes ends in more questions or differing evaluations of the theme (Arend, 2009). The teacher's role as facilitator also boosts a peer review process and helps students to learn appropriate responses to conflicting evaluations and opinions (Henderson-Hurley & Hurley, 2013).

Henderson-Hurley and Hurley (2013) suggested that the effort for more critical thinking is a holistic endeavor, which would require cooperation among different departments, divisions, and classes. The development of critical thinking skills is not only applicable to core subjects such as reading, math, language arts, science, and social studies. Kokkidou (2013) documented increases in creativity, innovativeness, as well as an increased awareness of the environment in which students and teachers live. Her findings established that by challenging students to think critically, teachers were finding themselves thinking more critically about their subject of expertise. Working to increase critical thinking by students has shown some promising

results for both students and educators. The establishment of professional learning communities allows educators to think critically about the methods they are using to teach, and is a good starting point for ideas about inclusion of critical thinking skills in the classroom (Smith & Szymanski, 2013). Activities such as writing essays and utilizing questions that adhere to Bloom's Taxonomy higher order thinking are examples of ways to engage students in critical thinking in the classroom (Smith & Szymanski, 2013). Another option for an activity that helps to enhance critical thinking is the use of collaborative group works to solve problems/questions in education (Snodgrass, 2011). According to Sadker and Sadker (2003) in an education that promotes critical thinking skills, learners are encouraged to interact with each other and develop social virtues such as cooperation and tolerance for different points of view. The need to teach content is a significant impediment to the teaching of critical thinking skills. However, Jenkins (2009) states that across all subjects' content knowledge should be taught through the integration of critical thinking the process should teach students to think. Engaging the brain through critical thinking and problem solving is much more beneficial than memorization of isolated facts (Matheny, 2009). Other barriers to the teaching of critical thinking include the class size, the amount of time allocated per lesson and teacher attitude (Slavin, 2009). The traditional pedagogical approach of the teachers serving as the deliverer of information and the student as a passive receiver of knowledge acutely impedes the development of critical thinking skills (Marzano, 2007). This activity can be utilized by having students create a study groups about the subject content they are studying or by having them analyze the information currently available in existing resources. Teachers in a classroom integrate the content of different subjects and plan lessons that arouse curiosity and higher levels of knowledge. It is also important that any changes to the curriculum be met with training about the new activities and how to utilize them to their full effect.

Integration of critical thinking is very important in teaching at the secondary school level, because it promotes content analysis and evaluation which in turn have a positive

impact on achievement of the students. In the area of critical thinking skills, few studies are available related to instructional design in Kenya. If teachers really want to modify the behaviour of learners in the classroom, it is indispensable to facilitate the critical thinking skills. Since studies are not available in area, the researcher has felt this as a need at present and hence the study. This paper explored level of critical thinking skills of learners in public secondary schools in Nyeri and Nairobi Counties in Kenya.

### **Purpose of the Study**

This paper explored level of critical thinking among learners in public secondary schools in Nyeri and Nairobi Counties in Kenya. These two counties were assumed to be representative of Kenya due to the fact of their geographical and cultural backgrounds; Nairobi being the capital city in Kenya is highly cosmopolitan with dissimilar ethnic, racial, religious, social-economic and cultural backgrounds. On the other hand Nyeri is largely rural with a homogeneous population. The following research objective guided the research to assess the level of critical thinking skills among learners in public secondary schools.

### **Hypothesis**

Ho1: There is no statistically significant difference in critical thinking among learners in boys, girls and co-educational schools.

Ho2: There is no statistically significant difference in critical thinking among in public secondary schools in Nyeri and Nairobi Counties.

### **Methodology**

The study employed a descriptive survey research design to examine critical thinking behaviours among learners in public secondary schools in Kenya. According to Kothari (2004) descriptive studies are intended to collect data relating to a phenomenon as it is devoid of any form of manipulation of the variables in the study. Further, descriptive design makes it possible to collect data over a large population within a short time (Kothari, 2004). This design was most suitable in relation to the variables of this research. Target population consisted of learners in public secondary schools in Nairobi

and Nyeri Counties. Nairobi had 86 schools with an enrollment of 10,796 students, while Nyeri had 214 schools with 58,424 students ((MoEST, 2013; NyeriCounty office, 2013). Thus the total number of learners in the two counties was 69, 220. The schools were stratified into three categories, namely; boys, girls, and co-educational (mixed) institutions. According to Kothari (2011) a sample size of 10% of the target population is an adequate representative for a large population. Thus, a sampling index of 0.1(10%) was selected from the three categories of schools, which gave; 2 boys’ schools from each county and 2 and 3 girls’ schools from Nairobi and Nyeri Counties respectively. Further, 17 and 4 mixed secondary schools in Nyeri and Nairobi Counties were sampled, this gave a total of 30 schools for the study. Sampling table by Kathuri and Pals (1993) was used to determine the sample size, which yielded a sample of 376 respondents for a population of 18,305 subjects. Since the sampled respondents were distributed in the 30 sampled secondary schools, the number of students selected from each of the schools was 13. The sample size of the study is presented in Table 1 presents.

**Table 1: Sample Size**

County	TotalNo.of schools			SchoolsSampled			StudentsSampled	
	Boys	Girls	Mixed	Boys	Girls	Mixed	Boys	Girls
Nairobi	20	24	42	2	2	4	52	52
Nyeri	19	25	170	2	3	17	137	150
<b>Total</b>	<b>39</b>	<b>59</b>	<b>212</b>	<b>4</b>	<b>5</b>	<b>21</b>	<b>189</b>	<b>202</b>

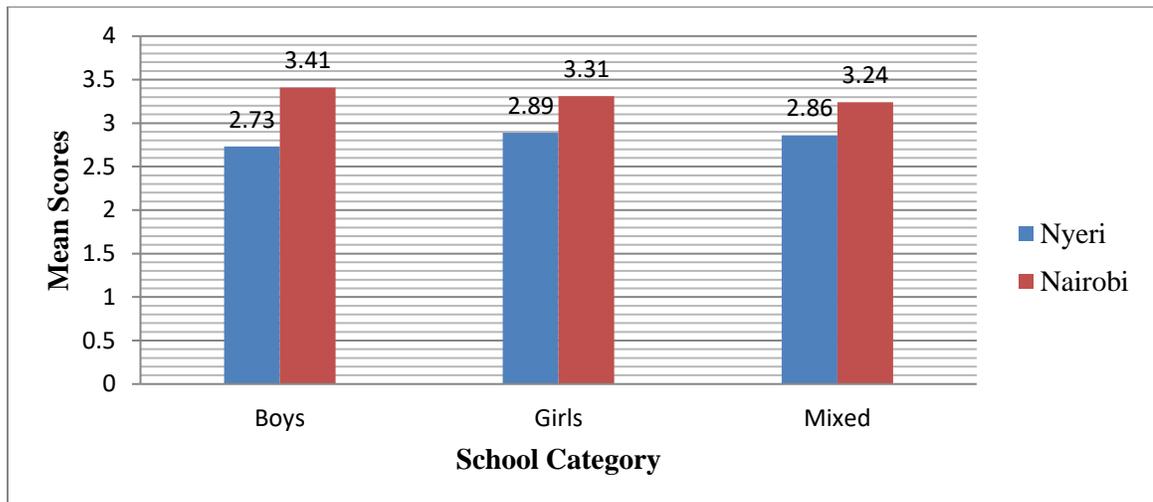
Data for this study was collected by means of a questionnaire administered to the students.

The questionnaire was adopted with modifications from Dindigal and Aminabhavi (2007) Psychosocial Competence Scale. The responses of the students were used to work out a mean score which rated the learners’ critical thinking skills on a scale of 1 to 5. Students who attained a mean score below 3.0 were rated as having a low level of the critical thinking skills, 3.0–3.9 represented a moderate level while mean scores that were above 4.0 were considered to exhibit a high level of the attribute. The computer software Statistical Package Social Sciences (SPSS) version 20.0 facilitated the data analysis. Data

analysis generated frequencies, percentages, means and standard deviations used for description and inferential analysis.

### Results and discussions

The findings of the study are presented according to the research objectives and hypothesis. The research objective assessed the level of critical thinking skills among learners in public secondary schools in Kenya. The respondents were provided with items in a likert scale to indicate their opinion and the scores obtained were used to calculate a mean score ( $\bar{x}$ ) of decision making skills of the respondents on a scale of 1 to 5. The findings are presented in Figure 1.



**Figure 4.12 Critical Thinking Skills by School Category and County**

Data analysis presented in Figure 1 clearly shows that learners in Nairobi County had higher levels of critical thinking skills compared to their counterparts in Nyeri County. In Nairobi County students in boys schools had a mean score of 3.41, mixed schools 3.24 and mixed schools 3.31. In Nyeri County, students in girls' schools had the highest mean ( $\bar{x} = 2.89$ ), this was followed by mixed schools ( $\bar{x} = 2.86$ ) while boys schools came last with a mean of 2.73. The findings of this study concurs with a study conducted by Aliakbari and Sadeghdaghighi (n.d) among Iranian students found out that students had low levels of critical thinking, in addition the study further revealed differences between male and female students in critical thinking ability with male learners outperforming

their female counterparts. Floyd (2011) states that there are widespread perceptions that students from rural areas have low critical thinking skills compared to learners from urban settings due to their strong cultural orientation. However, instead this view, more credence is being given to aspects such as linguistic aptitude and educational experience as contributing factors to learners' capability to exhibit critical thinking. The apparent deficiency in critical thinking abilities among student in Nyeri may be due to the fact that they have been raised under coherent societal norms where community welfare and traditional values are stressed. Consequently, rural communities place a lot of prominence on displaying regard for authority and conforming to the demands of societal values rather than standing out on individual convictions. This could be among the variables contributing to differences in critical thinking abilities between learners in Nyeri and Nairobi counties.

It had been hypothesized that there is no statistically significant difference in critical thinking among learners in boys, girls and co-educational schools. To test this hypothesis, one way Analysis of Variance (ANOVA) was computed. The statistical relationship between the levels of critical thinking skills among learners in boys, girls and mixed public secondary schools was presented as shown on Table 1.

**Table 2. ANOVA**

	<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>
Between Groups	15.221	29	.525	.849	.694
Within Groups	234.935	380	.618		
<b>Total</b>	<b>250.156</b>	<b>409</b>			

Table 2 shows that the results yielded p-value = .694 which was more than the alpha value  $\alpha > 0.05$  indicating that the differences in critical thinking was not statistically significant. Therefore the null hypothesis was accepted and it was concluded that the critical thinking skills of learners in boys, girls and mixed secondary schools were basically similar. Inferential analysis results obtained from the computed value of

ANOVA indicated the contrary; the differences observed were not statistically significant. This suggested that the overall critical thinking skills of learners in different school categories were the same. This agrees with the observations of Peron (2010) observed no differences in critical thinking skills among learners in different school categories. This was attributed to similar classroom practices and instructional strategies did not push students to give evidence and to reason; schools did not employ pedagogical approaches such as debates, brainstorming, journal writing, and questioning techniques in a way that stimulates development of critical thinking in the classroom. As a result learners did not develop high levels of critical thinking despite being in different school categories. Consequently, the similarities in the instructional techniques in different school categories could be a contributing variable to similarities in learners' critical thinking abilities. It had also been hypothesized that there is no statistically significant difference in critical thinking among in public secondary schools in Nyeri and Nairobi Counties. To test this hypothesis, independent sample t- test was computed for the means of the decision making skills for the rural and urban adolescents. The findings are provided in Table 3.

**Table 3. Independent sample t- test**

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Critical thinking	Equal variances assumed	3.352	.068	-4.869	409	.000	-.46846	.09621	-.65759	-.27933
	Equal variances not assumed			-5.127	192.381	.000	-.46846	.09137	-.64867	-.28825

Analyzed data presented in Table 3 showsthat the level of significance .000 was less than the p-value (.05). Therefore the null hypothesis was rejected, Ho2 (at  $\alpha = .05$ ) andconcluded that there is a statistical difference in critical thinking among adolescents in Nyeri and Nairobi Counties were different. This concurs with Leipert et al. (2012) who observed that several features of the rural context, such as geographical, sociocultural, economic, and health care contexts, are relevant to understanding the critical thinking skills of rural adolescents. Rural communities tend to be more religious and hold traditional values and beliefs, which can preclude rural adolescents from being assertive (Riddell et al., 2009). Therefore the contextual variables in the rural and urban settings

could be stimulating acquisition of the critical thinking skills among the learners differently.

### **Conclusion**

Descriptive analysis established that learners in Nairobi County had higher levels of critical thinking skills compared to their counterparts in Nyeri County. The apparent deficiency in critical thinking abilities among student in Nyeri may be due to the fact that learners in Nyueri County have been raised under coherent societal norms where community welfare and traditional values are stressed. Rural communities place a lot of prominence on displaying regard for authority and conforming to the demands of societal values rather than standing out on individual convictions. Inferential analysis results obtained from the computed value of ANOVA for the different school categories indicated the contrary; the differences observed were not statistically significant, suggesting that the overall critical thinking skills of learners in different school categories were the same. This was attributed to similar teaching methods across schools which could be contributing to similarities in learners' critical thinking abilities. However, independent sample t-test indicated that there was a statistically significant difference in critical thinking among learners in Nyeri and Nairobi Counties. These differences were attributed contextual variables in the rural and urban settings could be stimulating acquisition of the critical thinking skills among the learners differently.

### **Recommendations**

The findings elicit several suggestions for practice of instructional approaches in secondary schools in Kenya in addressing the apparent deficiencies in critical thinking skills among learners. From the findings of this study it is recommended on the need to address the instructional procedures used by secondary school teachers so as to stimulate critical thinking skills among learners in both counties. It is also important that acknowledge that the rural environment is not inspiring learners enough towards acquisition of critical thinking skills. In this regard, secondary schools in rural areas ought to put in place mechanisms that would compensate for this shortfall.

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## **Empirical Assessment of Demographic Factors Influencing Organizational Commitment in Secondary Schools in Kenya**

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### **ABSTRACT**

Organizational Commitment (OC) is increasingly becoming an important research concept in the fields of organizational behavior and human resource management. It's particularly relevant to schools where attainment of organizational goals is highly dependent on teachers' efforts. The purpose of this paper was to explore the factors that motivate teachers' commitment to their institutions. The study specifically aimed at establishing whether there is a relationship between teacher's demographic characteristics (age, gender, academic qualifications, tenure and position held) and School Commitment (SC). The study hypothesized that there is no significant relationship between teachers' personal characteristics and SC. The study adopted the descriptive research design. The study was conducted in Nakuru County and targeted 1670 secondary school teachers in in four sub-counties. A sample of 310 educators that was selected through stratified random sampling participated in the research. The groups that formed the sample strata comprised of school principals, deputies, heads of department, class teachers and subject teachers. Data was collected using the Allen and Meyer (1990) Three Component Model Employee Commitment Questionnaire. Relationship between variables was established by use of Spearman's rho and Linear Regression while the level of teacher commitment was established by use of descriptive statistics including means, frequencies and percentages. A high level of SC among Kenyan secondary school teachers was established. Age and the position held in the school was found to be positively related to SC. Negative correlation was established between SC, andacademic qualifications and tenure. There was no significant relationship between gender, and OC. Although a relationship was noted between most demographic variables and SC, the correlations were predominantly low leading to the conclusion that demographics was not a major factor in predicting SC. Consequently, the study recommends that further research be done to explore the other antecedents of SC such as conditions of service and school environment in order to explore their link to teacher commitment.

**Key words:** Demographic, commitment, age, tenure, relationship, characteristics

## **INTRODUCTION**

### **1.1 Background of the Study**

Behavioral scientists often argue that organizational leaders who know why their employees behave the way they do are better equipped to motivate them to contribute to the achievement of organizational goals (Gray and Starke 1988). The tendency for workers to react and interact in certain ways in various work situations is what is referred to as organisational behavior. It is the study of beliefs, attitudes, and behaviours displayed by workforce within an institution. In a school setting, principals can influence their teachers towards school commitment if they understand the factors that motivate them towards certain behavior.

The purpose of this study was to investigate the factors that influence organization commitment in the context of the Kenya secondary school system. The study was motivated by the perceived low level of commitment reported among teachers in Kenyan schools. In Kenya the teaching profession is characterized by frequent strikes by teachers seeking enhanced pay packages and improved conditions of service. Poor remuneration, poor working conditions, stagnation in one job group, frequent transfers and the low social status of the teaching profession leads to the perception that teachers in Kenya are demoralized and demotivated and therefore have low commitment.

For many years, researchers in the field of organizational behavior have been trying to better understand work attitudes and behaviour that affect the performance of workers as well as the effective functioning of organisations (Chughtai, 2008). One main work-related attitude that has been the central focus of studies in the field of organizational behavior is organizational commitment (OC). Meyer and Allen (1991) define OC as the psychological state that characterizes an employee's relationships with the organization and has implications for the decision to continue membership in the organization. By this token, School Commitment (SC) is viewed as a psychological connection that teachers have with their schools, characterized by strong identification and a desire to contribute to the accomplishment of school goals. It's the degree to which teachers identify with

their schools and their willingness to put forth a substantial effort on the school behalf and their intention to stay in the school for a long time (Wagner and Hollenbeck, 2010)

In this regard, commitment in the school context can be construed to imply the teachers' firm confidence in school objectives and epitomes, willingness to apply considerable effort when discharging school activities and a strong desire to continue teaching in that particular school. School commitment is evident when teachers are loyal and willing to exert effort on behalf of their school. It occurs when teachers display a high degree of goal and value congruency with the school and desire to maintain membership (Cohen 2007).

OC is particularly critical in a school setting since performance is highly dependent on the effectiveness of its teachers. Pohlman and Gardiner, (2000) reiterate that the nature of human resource in any organization is a major influence in the success of its endeavors. In order for schools to effectively disseminate its core mandate, teachers, a fundamental element of the educational system, have many fundamental tasks and responsibilities. The successful implementation of school curricular rests on teachers who are principally accountable for the educational programmes in their schools. It's for this purpose that a lot of attention should be given to the understanding of teachers' behaviors and performance within the organizational environment of their schools (Tsui and Cheng, 1999).

SC should therefore be one of the ultimate goals of the efforts of a school principal, since it leads to the creation of a productive teaching staff. Teachers who have a high level of SC work with a greater sense of loyalty and responsibility. Hartman (2000), reiterates that SC inculcates skills, knowledge and attitudes of the school community. As a critical resource in schools, teachers should develop a positive attitude towards their schools in order to be professionally productive. Yavus(2010)states that low committed teachers do not only deter the successful performance of their pedagogical duties but also affects the efficiency and effectiveness of the accomplishment of predetermined school goals in totality. Research has also found a relationship between organizational commitment and a

variety of organizational outcomes such as: increased employee performance and job satisfaction, reduced turnover, lower absenteeism rate and increased organizational citizenship behavior (Meyer et al, 2002; Trunk et al., 2013, Fornes, 2008; Babnik et al., 2014).

Mowday *et al.* (1982), further suggest four categories of variables that may influence organizational commitment: personal characteristics, job characteristics, work experiences, and Structural characteristics. This study opted to focus on teachers personal characteristics since they touch directly on the individual teachers and may be critical in explaining teachers' individual behavior. Personal characteristics, also referred to as demographic variables, have been the most commonly tested antecedents of organizational commitment and they include age, gender, education level, marital status, and tenure and family responsibilities.

Despite the many studies in OC, it is nevertheless noted that majority were conducted mainly in health, banking, hospitality, industry and manufacturing sector, thereby paying less attention to the educational setting, particularly secondary schools in Nakuru County, Kenya. This dearth of research on OC in the Kenyan education system motivated the conception of this research. The study is aimed at bridging this research gap by exploring the impact that teacher personal characteristics may have on their commitment. The study may help to initiate more extensive research to explore the various factors that affect teacher commitment in Kenyan schools. The findings will assist school principals in devising techniques for enhancing teacher commitment and thereby build more effective schools.

This paper examines commitment levels of teachers based on the Meyer & Allen (1997) Three-Component Model (TCM) of commitment. In this framework, Meyer and Allen recognize three dimensions of organizational commitment: affective commitment, continuance commitment and normative commitment.

Commitment is considered important in schools since it implies an intention among

teachers to persist in their quest to attain institutional goals. Therefore, schools regularly try to nurture commitment in their teachers in order to attain stability and reduce turnover rates. It is commonly held that highly committed teachers tend to strive harder and be more likely to exert extra effort to achieve school objectives. Studies have reliably demonstrated that commitment certainly contributes to a decrease staff turnover (Tett & Meyer, 1993; Meyer, Stanley, Herscovitch, & Topolnysky, 2002).

### **1.3 Objectives of the Study**

The general objective of the study was to find out whether there is any relationship between teachers' personal characteristics and the level of commitment they display towards their schools. The specific objectives included the following:

- 1) To establish the level of school commitment among secondary school teachers in Kenyan secondary schools;
- 2) To find out if there is any relationship between the age of teachers and the level of commitment they display towards their schools;
- 3) To determine the relationship between teachers' gender and their school commitment;
- 4) To examine the association between the academic qualification of teachers and their level of school commitment;
- 5) To assess whether a teachers length of service in a school has a relationship with their commitment to the school;

### **1.4 Hypotheses of the Study**

In order to achieve the study objectives, the researcher formulated the following null hypotheses to be tested:

**HO<sub>1</sub>** There is no significant relationship between the age of a teacher and their level of school commitment;

**HO<sub>2</sub>** There is no relationship between the gender of a teacher and their level of school commitment;

**HO<sub>3</sub>** There is no significant relationship between a teacher's academic qualifications and

their level of school commitment;

**HO<sub>4</sub>** There is no significant relationship between a teacher's tenure and their level of school commitment;

## **II EMPIRICAL LITERATURE REVIEW**

### **2.1 Organizational Commitment**

The intrigue with which the subject of OC has held researchers in the field of organizational behavior can be observed from how it has evolved over time. Earlier researchers such as March and Simon (1958) perceived OC as a give-and-take association involving parties making certain demands upon the other while providing something in return. Applied in the field of education, this observation implies that the more effective a school is, in providing openings for teachers to attain their various needs, the higher would be the inclination for them to contribute enthusiastically to school productivity. Etzioni (1961) distinguished among three forms of responses for organizational motivation for participation: moral, calculative, and alienative involvement. In schools, moral involvement would imply identification with and internalization of institutional values and goals. Calculative involvement would be displayed through a positive orientation to school management which nevertheless is less intense because it is grounded on a rational exchange of paybacks and rewards between the parties. Alienative involvement on the other hand would reflect negative bearing towards school authority, found in associations characterized by exploitation by management.

Porter et al. (1974) described organizational commitment as the relative strength of an individual's identification with and involvement in a particular organization. They viewed commitment as comprising of three elements: (a) a strong belief in and acceptance of the aims and ideals of the school; (b) a readiness to exert extensive effort on behalf of the school; and (c) a strong aspiration to remain in the school.

More recently a three-component model of organizational commitment was described by Meyer & Allen, (1987) who distinguished three forms of commitment: affective, continuance and normative commitment. In a school set up, affective commitment is characterized by a teacher's psychological attachment to the school displayed by such feelings such as allegiance, affection, friendliness, and belongingness. Continuance commitment is exhibited by the teachers choice for retention within the school because of the high personal costs they perceive are linked to their transfer from the school. Normative commitment on the other hand is shown through teachers the compulsion to stay in the school because of internalization of the school's vision and mission.

Mueller and Wallace (1992) discerned two dominant conceptualizations of organizational commitment: loyalty and intent to stay. Applied in education, loyalty can be viewed as a teacher's affective response to and identification based on a sense of duty and responsibility for their school.

## **2.2 Affective Commitment**

Allen & Meyer (1990) define affective commitment as "employees' emotional attachment to, identification with and involvement in the organization. In the context of this study, it is the moral commitment which occurs when teachers totally embrace the aims and tenets of the institution and become emotionally involved with and feel personally responsible for the school's level of achievement

Allen and Meyer (1990) have suggested that the precursor of affective attachment to the school can be divided into four categories: personal characteristics, job characteristics, work experiences and structural characteristics within their schools. It is suggested that individuals with a higher level of affective commitment to their organization demonstrate higher willingness to exert more effort at work (Meyer & Allen, 1997). Committed teachers therefore are likely to display high levels of performance, positive work attitudes, and a desire to stay in the school. Teachers who enjoy their work are likely to feel satisfied and contented with their jobs. This increased job satisfaction is likely to add to their feelings of affective commitment. Teachers with strong affective commitment continue teaching at their school willingly and eagerly.

### **2.3 Continuance Commitment**

Meyer and Allen, (1991) presented continuance commitment as referring to the awareness of the costs associated with exiting the school. Teachers whose primary link to the school is based on continuance commitment remain because they need to do so. They owe their commitment to the benefits associated with staying versus the personal costs associated with leaving the school such as pensions, seniority, social status, and access to social amenities that attach them to the school and would be at risk if the teacher left the school (Dawley, et al., 2005; Shahnawaz, and Juyal, 2006).

Continuance commitment refers to the teachers' perception relating to the costs associated with leaving their school. It is basically the fear of loss. It is based on teachers' awareness that leaving the school will come with certain costs which may inconvenience them. Teachers with a high level of continuance commitment continue teaching in the school because it is a necessity to do so. It is a calculative commitment which takes place when teachers base their relationship with the school on what they are getting in return for their efforts and what they would lose if they quit the institution. They focus on the pay and benefits that accrue to their involvement in the school. Such teachers usually exert their best effort only when the rewards match their expectations. Continuance commitment is seen when the teacher weighs the pros and cons of leaving the school. They feel the need to stay because the loss they experience by leaving is greater than the benefit they think they may gain in their new station. These perceived losses can be monetary gains or professional skills acquired over the years spent in the school. The severity of these losses often perceived to increase with age and length of service. Teachers are therefore likely to experience continuance commitment when they are in an established successful role or have had several promotions within one school.

### **2.4 Normative commitment**

Normative commitment refers to the teachers' perception relating to their obligation to stay. It occurs when the teacher feels a sense of obligation to their school even when they are unhappy or even if they want to pursue better opportunities. The teacher feels that

they should stay with their organizations because it is the right thing to do. This sense of obligation may arise if a teacher feels that the school has provided a reward in advance, for example, investing money or time in their training. It occurs when teachers remain with a school on the basis of expected standards of ethics and norms. These teachers value compliance, obedience, caution, and formality. Teachers high in normative commitment also feel that they ought to maintain membership in the organization, sometimes due to the pressures from colleagues (Allen and Meyer, 1996).

Normative commitment is viewed as the feeling of obligation to continue working in an organization. Teachers with a high level of normative commitment feel that they ought to remain with the school in which they are teaching (Allen and Meyer 1990). These teachers stay in the school because they believe it is the morally correct to do so and would therefore feel guilty if they left the school, even if they had to reject better job offers in other institutions.

Teachers' emotional attachment to their schools(affective commitment) has been considered a crucial determinant of devotion and loyalty.Committed teachers are therefore viewed to have a sense of belonging that makes them to identify with their institutions.This consequently enhances their participation in the school's activities and their disposition to pursue the school objectives and their aspiration to remain in the institution (Meyer and Allan, 1991). It's in this light, that relationship has been found between affective commitment in organisationsand absenteeism, performance, and turnover (Mathieu and Zajac, 1990; Meyer and Allen1997)

## **111 RESEARCH METHODOLOGY**

### **3.1 Research Design and Sampling**

The study employed the descriptive survey researchdesign. The target population of the study was 1670 teachers from four sub counties in Nakuru County, Kenya. Two stage cluster sampling was used to select the four sub counties which formed the study location. Cochran (1977) formula was used to determine the sample size and it yielded a sample of 310 respondents. Stratified sampling was used to select individual study

subjects. A total of 217 teachers responded to and returned the questionnaires giving a 70% response rate.

### **3.2 Data Collection Instrument**

The Data for this study was collected using an adaptation of Allen and Meyer (1990) Three Component Model (TCM) Employee Commitment Survey. The questionnaire consists of 24 statements with 8 items each measuring affective, continuance and normative commitments. Although the original Allen and Meyer (1990) questionnaire comprised of a 7 point Likert scale, the current study used a 5 point adaptation. The Allen and Meyer(2004) user guide for the scale recommends that it can be altered to suit specific research conditions without a major impact on reliability and validity. The 5 point response scale was found to be appropriate in this study for ease of data analysis and interpretation. This study also customized the items in the original questionnaire to suit the Kenyan secondary school set-up in which the study was based. The item ‘organization’ for instance was substituted with ‘school’ for the purpose of this study. Some items in the scale were reversed as recommended in Allen and Meyer (1990) in order to control for acquiescence response bias, that is, the tendency to answer affirmatively to questions irrespective of their content.

The reliability of the questionnaire was done through test-retest method by conducting a pilot study of 20 respondents. The correlation of the scores from the two sets of responses done using Cronbach’s alpha formula and coefficient of 0.78 was achieved indicating that the instrument was acceptably reliable. This reliability result is backed by tests done by previous researchers who also sought to establish the reliability of Allen and Meyer’s commitment scale. Allen and Meyer tested the reliability of their OC scale and achieved a reliability coefficient of 0.70 (Allen and Meyer 1990); Dunham (1994) found 0.74; Cohen (1996) achieved a reliability of 0.79

Although the OCS is standardised and has been pretested and used by many researchers over time, the questionnaire adopted for the current study was also checked for content and face validity. This was done by academic experts who were requested to check all the

items for their appropriateness in assessing the target variables. It was agreed that the scale was valid in measuring what it was purported to measure.

### **3.3 Data Analysis**

The study data was analysed with the aid of the Statistical Package for Social Sciences (SPSS). Descriptive statistics including frequencies and percentages were used to describe the study findings while inferential statistics including Spearman's Rank Correlation and Multiple Linear Regression were used to test the hypothesis.

## **1V FINDINGS AND DISCUSSIONS**

### **4.1 Demographics**

This section presents the demographic data of the sample under study. The overriding objective of the study was to establish whether teachers' demographic variables are significant predictors of their school commitment. The demographic variables that were under investigation included the age, gender, academic qualifications and tenure of the respondents. This study hypothesized that teachers' demographic characteristics will have no relationship with their school commitment.

**Table 1**

**Demographic Data of the respondents**

<b>Variable</b>	<b>Attributes</b>	<b>N</b>	<b>%</b>
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Age	Below 25	55	25.3
	25-35	72	33.2
	36-45	50	23
	46-55	37	17.1
	Above 55	3	1.4
Gender	Male	102	47
	Female	115	53
Academic Level	Diploma	33	15.2
	Bachelors	148	68.2
	Masters	33	15.2
	PhD	3	1.4
Position Held	Principal	17	7.8
	Deputy	29	13.4
	Head Of Department	111	51.2
	Class Teacher	53	24.4
	Subject Teacher	7	3.2
Tenure	Under 5	109	50.2
	6-10	69	31.8
	11-15	25	11.5
	16-20	14	6.5
<b>Total Number of Respondents</b>		<b>217</b>	

Majority(58.5%)of the respondents were aged below 35 years indicating that most schools had young teachers. There was a relative gender balance in the sampled schools with 53% being female while 47% were male.A majority of the teachers 68.2% had first degrees while 15.2% had diplomas. Only 16.1% teachers had postgraduate qualifications. Heads of departments formed majority (52.5%) of the respondents while the rest comprised of classteachers (7%), deputy principals(29%), principals 17% and subjects teachers (7%)without administrative responsibilities in the schools. Majority of the teachers (81%) had been in their current stations for less than 10 years.

## 4.2 Descriptive Analysis

This section presents the descriptive findings on the levels of SC registered in the schools. The level of affective, continuance and normative commitment was calculated by taking the average of the means scores of each of the three components. This yielded a composite mean for each commitment component. The average of the means of the three commitment components was then computed to yield the overall SC score.

**Table 2**  
**Teachers Level of Affective Commitment**

Affective Commitment Construct	Percentage					Mean	SD
	1	2	3	4	5		
Happy to spend the rest of career in school	16.6	32.3	18	18.9	14.3	2.8	1.45367
Enjoys discussing school with people outside	8.3	24	6	37.8	24	3.5	1.35322
Feel that school problems are own	14.7	23.5	1.4	34.1	26.3	3.3	1.30547
Can be attached to another school as to this	21.2	32.7	4.6	31.8	9.7	2.8	1.22558
Doesn't feel like "part of family" in the school	13.8	2.8	0	47.9	35.5	3.9	1.32297
Does not feel emotionally attached to school	5.1	15.7	0	37.8	41.5	3.9	1.30272
School has personal meaning to them	11.1	17.1	4.1	43.3	24.4	3.5	1.45367
Does not feel strong sense of belonging	8.3	13.8	1.4	36.9	39.6	3.9	1.35322
<b>Composite Affective Commitment</b>						<b>3.5</b>	

Scale: 1=strongly disagreed; 2= disagree; 3=undecided; 4= agree; 5= strongly agree.

Affective commitment, as composite construct, which yielded an overall mean of 3.5 in a 5 point Likert scale. This indicates that the level of affective commitment was high meaning that the teachers are happy to be in their respective schools. They are emotionally attached and have a strong sense of belonging to their schools. Most of the affective commitment indicators had high means ranging from 3.3 to 3.7

**Table 3****Teachers Level of School Normative Commitment**

Continuance Commitment Construct	Percentage					Mean	SD
	1	2	3	4	5		
I am not afraid to quit job without another	6.5	20.7	10.6	33.6	28.6	3.6	1.27775
I finds it hard to leave school right now	17.7	26.3	8.8	35.5	12.0	3.0	1.34155
Life would be disrupted if I leave school now	17.5	24.4		40.6	17.5	3.1	1.43719
It wouldn't be costly for to leave my school now	24.0	22.1	5.1	27.2	21.7	3.0	1.51880
My staying in school is a matter of necessity	18.0	28.6	3.2	30.0	20.3	3.0	1.46163
I have too few options to consider leaving school	18.9	35.0	4.1	22.1	19.8	2.8	1.44551
I can't leavethis school for scarcity of alternatives	25.3	31.3	2.8	25.3	15.2	2.7	1.44616
Leaving would requires personal sacrifice	17.5	38.7	2.8	17.5	23.5	2.9	1.47520
<b>Composite Continuance Commitment Mean</b>						<b>3.0</b>	

Scale: 1=strongly disagreed; 2= disagree; 3=undecided; 4= agree; 5= strongly agree.

Most of the continuance commitment constructs were rated above average with means ranging between 3.0 and 3.6. This is an indication of a SC level that is above average. It means that the respondents felt it necessary to remain in their schools because it would be costly for them to leave.

**Table 4****Level of School Normative Commitment**

Normative Commitment Construct	Percentage					Mean	SD
	1	2	3	4	5		

People move from school to school too often	6.0	33.6	5.5	41.9	12.9	3.2	1.21217
A person mustn't always be loyal to their school	6.0	23.5	2.5	31.3	33.6	3.6	1.32026
Jumping from school to school is not unethical	14.7	32.3		24.4	28.5	3.2	1.50690
I haven't moved due to moral obligation to stay	12.0	23.0	6.0	37.3	21.7	3.3	1.35818
I wouldn't feel it was right to leave my school	24.9	43.8		20.3	11.1	2.5	1.35096
I was taught the value of being loyal to my school	8.3	25.8	4.6	35.5	25.8	3.4	1.33618
People should stay in one school for most of career	24.4	51.6	4.1	12.9	6.9	2.3	1.16672
<b>Composite Normative Commitment Mean</b>							<b>3.1</b>

Scale: 1=strongly disagreed; 2= disagree; 3=undecided; 4= agree; 5= strongly agree.

Table 2 shows that the respondents rated five of the normative commitment indicators above average with mean scores ranging from 3.2 to 3.6 while two indicators registered low means ranging from 2.3 to 2.5. This indicates a high level of normative commitment in the schools. This means that teachers are happy with what their schools have done for them. This shows that the teachers appreciate the benefits associated with being in the school and therefore feel obligated to remain in the school. They see their schools as deserving their loyalty and they also feel the moral responsibility to dedicate themselves to their schools.

**Table 5**  
**Level of Overall School Commitment**

Type of commitment	N	Mean
Affective commitment	217	3.52
Normative Commitment	217	3.13
Continuance Commitment	217	3.1

<b>Overall School Commitment</b>	<b>217</b>	<b>3.28</b>
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Overall school commitment was calculated by taking the average of the affective, continuance and normative commitment means. The overall cumulative school commitment score was 3.28 indicating that SC among the teachers under study was high.

### 4.3 Correlation Analysis

This section presents correlation results for teachers’ demographic characteristics against their level of school commitment. Spearman’s Rank Correlation coefficient was computed to assess the relationship between the respondents’ demographic characteristics and their level of school commitment.

**Table 5**  
**Relationship between for Age and School Commitment**

		Age	School Commitment
Age	Correlation		
	Coefficient	1.000	.252
	Sig. (2-tailed)		.000
	N	217	217
School Commitment	Correlation		
	Coefficient	.252	1.000
	Sig. (2-tailed)	.000	
	N	217	217

The study established a positive significant relationship ( $r=.252$ ,  $n=217$ ,  $p>.05$ ) between the teachers’ age and the level of commitment to their schools. This means that the level of school commitment tended to rise with increase in age. The first null hypothesis of the study ( $H_{01}$ ) which predicted that there is no significant relationship between teachers’ age and affective commitment to their schools was therefore rejected.

**Table 6****Relationship between Gender and School Commitment**

		<b>Gender</b>	<b>School Commitment</b>
Spearman's rho	<b>Gender</b>	Correlation Coefficient	1.000 .014
		Sig. (2-tailed)	.837
		N	217
	<b>School Commitment</b>	Correlation Coefficient	.014 1.000
		Sig. (2-tailed)	.837
		N	217

Nosignificant relationship was established between gender and SC among teachers ( $r = .014, n = 217, p > .05$ ). The second null hypothesis ( $H_{O2}$ ) which stated that there is no significant relationship between gender and teachers' SC is therefore supported. This is construed to imply that the gender of a teacher does not affect their level of commitment to their schools.

**Table 7****Relationship between Level of Education and School Commitment**

		<b>Qualification</b>	<b>School Commitment</b>
Spearman's rho	<b>Qualification</b>	Correlation Coefficient	1.000 -.318
		Sig. (2-tailed)	.001
		N	217
	<b>School Commitment</b>	Correlation Coefficient	-.318 1.000
		Sig. (2-tailed)	.001
		N	217

The study findings also established a significant negative relationship between the academic qualifications and commitment levels of teachers ( $r = -.318$ ,  $n = 217$ ,  $p > .05$ ). The third hypothesis stating that there is no relationship between academic qualifications and SC was therefore rejected. This means that a teacher who is highly educated is less likely to be committed to their school than one who has less qualifications. This finding is in line with that of Salami (2008), who found that there is a significant negative relationship between education and organizational commitment. The implication of this finding is that teachers who are highly educated may not find it difficult in securing other jobs in other sectors of the economy and are, therefore, less likely to be committed to their organization because they have more opportunities for leaving the teaching profession.

**Table 8**  
**Relationship between Tenure and School Commitment**

		Position Held	School commitment	
Spearman's rho	Position Held	Correlation Coefficient	1.000	
		Sig. (2-tailed)	.002	
		N	217	
	School commitment	Correlation Coefficient	.212	1.000
		Sig. (2-tailed)	.002	
		N	217	217

The fifth objective of this study was to establish whether a teacher's length of service in a school has a relationship with their SC. The study established that there was a negative correlation between the number of years spent in the school and SC ( $r = -.212$ ,  $n = 217$ ,  $p > .05$ ) indicating that commitment reduced with an increases number of years spent in a school. The study hypothesis stating that there is no relationship between tenure and SC

was therefore rejected.

## 5.0 Regression results

Multiple regression analysis was used to establish the extent to which demographic variables predicted school commitment among teachers. All the predictor variables were simultaneously entered into regression analysis to determine the independent influence. The multiple correlations were used to show the combined contributions of the independent variables. The model summary is depicted in Table 9.

**Table 9**  
**Regression Model for Demographics and SC**

Regression Results				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.287 <sup>a</sup>	.082	.056	.57578

Table 9 presents the regression model depicting the relationship between teachers' demographic attributes and school commitment. The R value indicates a weak correlation (.287) between school commitment and teachers personal attributes. The value of R square ( $R^2=.082$ ) means that demographics can account for only 8.2 % of the factors that predict SC in Kenyan secondary schools. There might be other factors that can explained the relatively high level of commitment ( $\mu=3.28$ ) indicated by the teachers. This implies that 92% of what motivates teachers towards high commitment in secondary schools in Kenya cannot be explained by personal characteristics alone. There must be other variables that also have an influence.

## 1V SUMMARY AND DISCUSSION

It's evident in this study that OC is a concept that is being studied in many research efforts worldwide. This is because it is a crucial determinant of organizational effectiveness. This study attempted to examine the relationship between the personal

characteristics and levels of commitment of various categories of educators in secondary schools in Kenya. The study specifically focused on age, gender, tenure, educational qualifications and position held, and attempted to establish how they linked to SC.

The findings of the study revealed that the SC levels of these educators is above average. It was however established that although demographic attributes played a role in determining SC, their effect was not fundamental given that the correlation coefficients were relatively low. Age and position held was the only variable that registered significant positive correlation with SC. This means that the levels of SC rose in concordance with the age and seniority of the educators.

Findings across researches have yielded contradicting results on the relationship between age and commitment, raising the question as to whether age really has any significant effect on workers commitment. Despite contradicting results across empirical literature, most studies concur with this study's finding. Meyer and Allen, (1998) for example found a significant link between age and organisational commitment. Other researchers who found a significant and positive relationship between age and employees' commitment include Mathieu & Zajak (1990), Allen and Meyer (1990), Steers (1997; Angle and Perry (1991), De Gierter et al. (2011) and Salami (2008). Sommer, Bae & Luthans (1996) also found that the organizational commitment among Korean employees increases with age. (Newstrom, 2007) attributed this link between age and commitment to the fact that older people through experience, tend to lower their expectations to more realistic levels and adjust themselves better to their work situations.

In the context of this study, this finding could perhaps be linked to the expectation that older teachers have higher school commitment due to higher job satisfaction derived from the high job groups they hold, or higher responsibilities they hold in their schools. Teachers in the younger age bracket may not develop emotional attachment to the school due to the short span of time in which they have been in the institution.

The general perception is that older employees have higher commitment due to higher job satisfaction and better positions in the organization. It's thought that younger employees may need more time to develop emotional attachment to their organizations.

Another possible explanation for this link is that there are fewer employment opportunities to older employees and that such employees may find that leaving the organization may be more costly to them than staying (Mowday et al., 1982).

The study established no relationship between gender and the level of SC in the schools under study. The question as to whether there is a relationship between gender and levels of organizational commitment has often, emerged as an important research issue. Among the myriad studies that have explored the correlates of organizational commitment, the literature on the relationship between gender and organizational commitment has had mixed results. The results of this study therefore concurs with and yet contrasts with several earlier studies in equal measure. Some researchers have advocated that women are less committed to their organisations than men (Yammarino & Dubinsky, 1988; Karrasch, 2003; Schwartz, 1989). Others found no gender differences in organizational commitment (Riketta, 2005; Meyer et al., 2002; Thorsteinson, 2003). Chughtai al Zafar (2006) found no significant relationship between gender and organizational commitment. This could perhaps be a result of personality characteristics such as self-efficacy defined as individual capacity to perform tasks (Bandura 1986).

Some gender arguments revolve around claims that men and women have different psychological traits that predispose them towards different levels of commitment. Women for instance are said to have more extensive social and affective interests than men do, (Giele 1998) perhaps as a result of gender socialization practices. Such differences might lead to higher commitment on the part of women. Another opinion suggesting that women will exhibit higher levels of organisational commitment focuses on the fewer choices that females often face within the job market. Some of these limitations may include domestic responsibilities that prevent women from searching for jobs beyond the geographic area in which they reside since they prefer being close to their families. In light of these limited alternatives, it is argued that dissonance-reduction processes lead female teachers to place greater value on their schools than would males in comparable circumstances.

A significant negative correlation was registered between the respondent's academic qualifications and SC. This means that SC deteriorated with enhanced educational level. This revelation is concordant with the findings Steers (1977) who likewise established a negative relationship between the level of education and OC. Al-Kahtani (2012) and Igbal (2011) opined that more educated people may have high expectations which the organization may be unable to meet. According to Igbal (2011) highly educated individuals may have less commitment since they may have other opportunities of employment. Mathieu & Zajac (1990) confirmed that the relationship was significantly strong. Salami (2008) however found a positive association between educational level and commitment. He observed that there is the likelihood that employees with high academic qualifications occupy higher ranks in the organizational structure and therefore have more responsibilities which require more commitment to the organization.

The fourth objective of this study was to establish whether a teacher's length of service in a school has a relationship with their commitment to the school. The study established that there is a significant negative correlation between tenure and school commitment. This means that school commitment reduces with increased number of years in the school. Perhaps this scenario can be attributed to the teacher employment and posting policy in Kenya. In the Kenyan context, employment and posting is the mandate of Teachers Service Commission the central teacher management agency. Teachers therefore have little choice on the location of the school they are going to be employed. Due to limited teacher vacancies most teachers end up in schools don't like. Such teachers usually seek for transfers to their schools of choice which often takes time. The more year's teachers spent in such schools, the less committed the affected teachers would become. Research findings from other counties however achieved results that contradict the findings of this study. Meyer and Allen (1997), found a positive relationship between tenure and OC. They observed that uncommitted employees leave an organization while those with a high commitment remain

Multiple regression analysis was run to determine the extent to which the demographic

variables under study influenced dependent variable. The results indicated that the dependent variables played a minimal role in influencing commitment since they accounted for only 8.2% of the factors influencing SC. This means that other factors outside the study accounted for 92 % of the factors influencing SC. The literature indicated that there are other variables that significant in determining the level commitment of employees in an organization including school culture, location, environment, leadership style, organizational structure etc. This study therefore opens other areas for further research that could explore the extend to which they influence the level of commitment in schools.

This study faced certain limitations. Firstly, the study targeted teachers from four sub counties of Nakuru county and the results might therefore not be generalised to all schools in Kenya.

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# **Higher Education Curriculum Orientation and Performance of Universities in Kenya: Industry Linkage Strategies**

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## **ABSTRACT**

Quality education and training can only be achieved by orienting the academic curriculum in such a way that its content reflects industry demands. It must also be continuously reviewed after every cycle to capture the emerging issues in the dynamic economic environment. This study sought to contribute to knowledge by assessing the extent to which linking university curricula to the needs of the industry would influence performance of universities in Kenya. Resource based view was used as the main theory anchoring the study. Cross-Sectional survey was adopted as the research design. The population of the study consists of sixty five (65) public and private universities incorporated in Kenya. Out of this, a sample of forty seven (47) universities which had undergone at least one (1) graduation cycle was taken. Primary and secondary data was collected using semi-structured questionnaires and review of existing university documents and regulatory bodies websites respectively. Correlation and regression analyses were used to test hypotheses. ANOVA was used to determine the differences between group means. Balanced score card was appropriately used to represent financial and non-financial aspects that constitute performance indicators. It was established that positive and significant correlations existed between curriculum orientation and university performance. The findings offer insight to university authorities and policy makers by reinforcing the role of collaborative strategies when developing and reviewing academic curricula. University authorities need to enhance collaboration with the industry in order to substantially exploit the synergies resulting from enhanced symbiotic correlations between university and the industry. The main limitation of this study is that primary data was collected from only one respondent per university but common methods bias was mitigated through the use of additional secondary data to validate primary data. Thus, the limitation did not affect the credence of the results as presented and discussed.

**Key words:** Curriculum Orientation, Linkage Strategy, Industry, Performance, University

## *Introduction*

There is a growing concern that the knowledge and skills acquired by students in most African Universities do not sufficiently meet the requirements of the industry and the

wider economy. This mismatch, coupled with under-training in the critical skills of analytical thinking, communication and problem-solving is blamed for the emerging high graduate under-employment and unemployment in many parts of Africa. According to Pauw (2008), African Universities have been criticized as ivory towers that churn out graduates who are largely irrelevant to the needs of employers and the social, economic, and technical challenges facing African economies. There is a critical need for Universities to update and upgrade curriculum to ensure that students graduate with relevant skills and competencies for job fit. Quality educational programmes can only be achieved by orienting University curricula in such a way that the industry demands are adequately fused in the developed or reviewed content. The curricula must also be continually reviewed after every complete cycle in order to capture the emerging issues in the dynamic industry environment. The curriculum must also be consistent with institution's mission and clearly defined outcomes intended to produce relevant graduates in the ever changing technological world. Clear policies must be formulated and implemented to guide curriculum development and review. The entire process must be highly inclusive in order to take care of all the needs of stakeholders involved at every stage (Martin, 2000). In Kenya for example, most Universities have inadequate resource capacity to adequately address the needs of courses in Technology and science related disciplines. They also have inadequately trained manpower to deliver the courses that they provide, thereby making the quality of some of their graduates questionable (Weidman, 1995). According to a report by Commission for University Education (2013), Universities are tasked with the pivotal role of helping Kenya achieve her development goals through education, research and innovation. Curriculum review ensures that degree programmes produce graduates with the required knowledge, skills and competencies for the emerging and dynamic industry issues relevant for workforce. The report further states that, very few Universities adequately involve stakeholders during curriculum development and review process and that just a few professional bodies work closely with the Universities. Proper curriculum orientation requires multi-sectoral approach, where all concerned stakeholders are involved and fully engaged in order to develop relevant curricula that reflect the interests of potential employers, community expectations, and that provide opportunities for self-employment. Ozsoy (2011)

researched on 179 universities across Europe, Latin America and Sub-Saharan Africa. He established the proposition that the performance of a University will be positively associated with its intellectual capital and their capabilities, curriculum orientation, enhanced industrial attachment, teaching and learning facilities and collaborative research. This reinforces the need for linkage strategies with the industry. Studies exploring linkages between higher education and industry have shown that having a strong symbiotic relationship between the two would enable the synergies to be exploited. This implies that performance of a higher learning institution should be measured in terms of quality of collaboration it has with industry. According to Eshiwani (1999), a University can only remain relevant if it promptly responds to the changing technology and emerging industry demands, by formulating proper collaborative strategies. The industry cannot afford to operate in isolation and must foster linkages with universities. Universities on the other hand, cannot ignore the industry which is the consumer of its output and employer of its graduates. This study sought to establish the influence of curriculum orientation on University performance. Different organizations use varying measures of performance. These measures may be quantitative or qualitative. Kaplan and Norton (2008) introduced balance scorecard which considers financial and non-financial measures of performance such as internal business process, learning and growth and customer perspective. This study has appropriately used balanced score card to measure university performance.

### **Literature Review**

Curriculum is the tool which guides teaching and learning process. According to Jita (2006), Curriculum can be defined as a web of interrelated and aligned activities working together to achieve certain learning outcomes. It is a plan for learning and teaching process. Curriculum development is a multi-step and cyclical process aimed at designing an effective learning content and resources required to achieve the stated objectives. The development of study contents, learning and teaching resources, work plans and assessment of students are all based on curriculum (Hooghoff and Bron, 2008). Curriculum is viewed as the responsibility of learning institutions and all stakeholders in the society as a whole. The is critical need for stakeholder participation and experts or

professional bodies engagement in all aspects of higher education in order to develop curricula that are relevant to industry needs. According to Jita (2006), the processes of stakeholder participation in the higher education quality assurance system have been rather limited and poorly conceptualized. Regular curriculum review is essential to ensuring quality in all academic programmes. The goal is to ensure that programs continue to offer relevant and emerging issues in the industry and to offer students learning experiences that are inspiring, intellectually challenging and transformational. According to Grant (2010), strategy is the link between the firm and its environment. It is broadly defined to include both goals and means of achieving them. Mintzberg (1987) proposed five definitions of strategy, namely; strategy as a plan, a ploy, a pattern, a position and a perspective. Johnson and Scholes (2006) defined strategy as the direction and scope of an organization over the long term. Strategy thus consists of the means an organization chooses to move from its present state to its future. It focuses on future performance as an organizational link with the external environment and considers internal resources in order to attain a competitive advantage. Theories of strategy embody specific explanations for why firms within and between industries differ in their performance. For example, the market positioning framework views differences between firms as resulting from the different characteristics of the markets they operate in. Resource based approach asserts that firm differences arise from situations where firms actively seek to differentiate themselves through their unique competencies and capabilities (Grant, 2010). The economic sector cannot afford to operate in isolation and must foster linkages with universities. This is because it requires qualified manpower to provide necessary services. Universities on the other hand, cannot ignore the economic sector which is the consumer of the knowledge and products generated. Strategies used to achieve quality University curriculum should revolve around stakeholders' engagement, professional bodies' engagement and regular curriculum review. According to Koskei (2015), curriculum development is concerned with reviewing, planning, developing, implementing and maintaining curriculum while ensuring that the stakeholders engaged in this process have a high level of commitment to and ownership of the curriculum. In formulating policy, the challenge lies in the discourse on the form, content, aims and goals of curriculum, often referred to as curriculum orientation. According to Koskei

(2015), effective curriculum development and review requires that proper industry analysis is first and foremost conducted in order to infuse market needs identified by all stakeholders and professionals into the content. Second, design and development should then be done in accordance with outcomes based on learning principles. He further states that the delivery of curriculum should be done using a wide variety of mechanisms appropriate to the modern learning market. This model proposes an integrated approach to curriculum development based on multi-stakeholder engagement whose end-result is a relevant and industry-driven curriculum.

### *Hypotheses of the Study*

The following hypotheses were derived from the literature debate.

**Hypothesis 1:** There is a significant positive correlation between curriculum review and University performance.

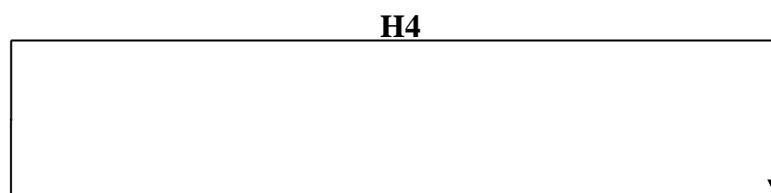
**Hypothesis 2:** There is a significant positive correlation between stakeholders' engagement in curriculum development and University performance.

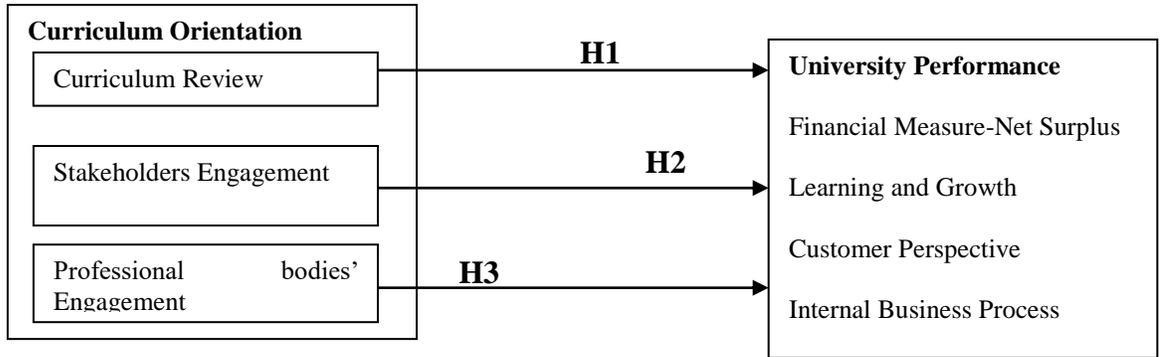
**Hypothesis 3:** There is a significant positive correlation between professional bodies' engagement in curriculum development and University performance.

**Hypothesis 4:** There is a significant joint effect of curriculum orientation on University performance.

### *Conceptual Framework*

An integrated framework to respond to the knowledge gaps identified in the literature review in this study has been designed with two components. While curriculum orientation constitutes independent variable, organisational performance constitutes dependent variable. The study determined the direct relationship between curriculum orientation and university performance.





**Independent Variables**

**Dependent Variable**

**FIGURE1: CONCEPTUAL MODEL**

## *Methods*

The study adopted descriptive cross-sectional survey design. According to Irungu (2007), descriptive cross-sectional survey is appropriate where the overall objective is to establish whether significant associations among variables exist at some point in time. The cross-sectional approach involved collecting and comparing data from the phenomena as at the time of study. The combination of qualitative and quantitative data enabled adequate explanation of the variables and predictions in their behaviour without resorting into inquiries of the temporal effect. The design enhanced uniform data collection and comparison across respondents. In order to undertake comparative analysis between private and public universities, independent sample t-test, standard deviation, arithmetic mean and coefficient of variation (CV) were used. C.V was used to measure variability and consistency in scores of different universities when arithmetic mean and standard deviation is compared. Correlation analysis was used to check the nature and direction of relationships between independent and dependent variables. As at the time of this study, there were a total of sixty five (65) universities operating in Kenya according to Commission for University Education report (2013). Thus, population of this study comprised 65 public and private universities incorporated in Kenya. From the 65, forty seven (47) universities which had undergone at least one (1) graduation cycle were sampled. Out of this, twenty two (22) were public and twenty five (25) were private universities. This sample size of 47 constitutes 72% of the population and it is way above the required 10% as a representative sample for a homogenous population. According to Kothari (2004), a population sample constituting 10% and above is appropriate if the researcher is dealing with a homogenous population. Reliability test was undertaken using Cronbach's Alpha whose value was established as 0.992, way above 0.7 as the rule of thumb for testing reliability of data collection instrument. Table 1.1 shows summary reliability scores for 27 questions which were constructed to investigate the study variables.

Cronbach's Alpha	N of Items
.992	27

**Table 1.1: Total Statistics on Curriculum Orientation**

variable	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Cronbach's Alpha if Item Deleted
Effectiveness and frequency of curriculum review	91.4651	956.255	.944	.991
Stakeholders engagement in curriculum development and review	91.6047	961.769	.970	.991
Professional bodies' engagement in curriculum development and review	91.1395	953.790	.891	.991

Table 1.2 shows reliability scores for 11 questions which were constructed to investigate University performance variables. Cronbach's Alpha was established as 0.975, which was also way above 0.7 as the rule of thumb for testing reliability of data collection instrument.

### Reliability Statistics on University Performance

Cronbach's Alpha	N of Items
.975	11

**Table 1.2 Total Statistics on University Performance**

Variable	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Cronbach's Alpha if Item Deleted
Net surplus	34.9318	131.693	.909	.972
Total amount of scholarship awards or grants for students	34.9545	130.091	.921	.972
Total number of Students	35.1136	126.801	.955	.970
Teacher to Student ratio	34.9773	127.930	.957	.970
Supervisor to Student ratio	35.0682	128.205	.875	.973
University webometrics ranking in Kenya	35.5682	143.739	.429	.984
Total number of stakeholder conferences held	35.0682	129.600	.863	.973
Total number of collaborative activities with other institutions held	35.0455	128.230	.900	.972
Total number of industry visits made	34.9545	126.882	.939	.971
Total number of guest speakers hosted	34.8864	125.824	.942	.971
Performance of our university has greatly increased over the past five years	34.8864	130.940	.910	.972

## **Results**

Structured questionnaires were administered in the selected forty seven (47) Universities to gather data on frequency of curriculum review and the extent of stakeholders and professional bodies' engagement in curriculum development and review process. Table 4.8 shows the descriptive statistics for each item.

**TABLE1.3: DESCRIPTIVE STATISTICS ON CURRICULUM ORIENTATION**

Variable	Frequency			Mean Score			Standard Deviation			Coefficient of Variation (CV)		
	Pu	Pr	Co	Pu	Pr	Co	Pu	Pr	Co	Pu	Pr	Co
Stakeholdersengagement	21	2	44	3.0	3.4	3.3	1.4	1.2	1.3	44	3	40
nt		3									6	
Frequency of curriculum review	21	2	44	3.1	3.5	3.3	1.4	1.2	1.3	35	3	40
		3									3	
Professional Bodies' engagement	21	2	44	3.4	4.2	3.8	1.4	1.4	1.5	39	3	38
		3									4	
Average	21	2	44	3.2	3.6	3.5	1.5	1.3	1.4	41	3	40
		3									5	

*Key: pu-public universities; pr-private universities; Co-combined (all universities)*

Table1.3 shows that Private Universities scored higher in frequency of curriculum review (3.5 and lesser variability of 33%) compared to a mean score of 3.1 and wider variability of 33% by public universities. Private Universities also obtained higher mean scores (3.4 and 4.2) in stakeholder and professional bodies' engagement in curriculum development and review process respectively. In overall, private universities recorded stronger linkage strategies (mean score of 3.6 and variability of 35%) compared to public universities (mean score of 3.2 and variability of 41%) in the area of curriculum orientation. In general, the combined mean score on curriculum orientation for all private and public universities is 3.5 out of 5 which approximates to 70% on a percentage scale.

*Table 1.4 Independent Samples t Test for Equality of Means on Curriculum Orientation*

t-test for Equality of Means							
Variable	t	df	Sig. (2-tailed)	Mean Difference	Std. Error	95% Confidence Interval of the Difference	
						Lower	Upper

Effectiveness and frequency of curriculum review	42	.33483	-.38716	.39684	1.18801	-.41368
Stakeholders engagement in curriculum development and review	42	.33647	-.38302	.39394	1.17802	-.41198
Professional bodies' engagement in curriculum development and review	42	.05792	-.83644	.42904	1.70227	-.02939

The mean scores for the indicators of curriculum orientation were compared by computing independent sample t statistic for equality of means at 95% level of confidence and 42 degrees of freedom to test the significance of the difference between sample means of private and public universities. As shown in table 1.4 values of independent sample t-test are negative i.e. less than 2.5 and all p values are greater than 0.05. It is therefore concluded that there is significant difference between curriculum orientation mean scores when private and public Universities are compared.

**TABLE 1.5: DESCRIPTIVE STATISTICS ON UNIVERSITY PERFORMANCE**

Variable	Frequency			Mean Score			Standard Deviation			Coefficient of Variation (CV)		
	P	Pr	Co	Pu	Pr	Co	Pu	Pr	Co	Pu	Pr	Co
Net surplus	2	2								35.	28.	30.6
	1	3	44	3.4	3.8	3.6	1.2	1.1	1.1	3	9	

Total amount of scholarship awards or grants for students	2	2									36.	33.	33.3
	1	3	44	3.6	3.6	3.6	1.3	1.2	1.2	1	3		
Total number of Students	2	2									42.	37.	38.2
	1	3	44	3.3	3.5	3.4	1.4	1.3	1.3	4	1		
Teacher to Student ratio	2	2									40.	32.	36.1
	1	3	44	3.5	3.7	3.6	1.4	1.2	1.3	0	4		
Supervisor to Student ratio	2	2									41.	36.	40.0
	1	3	44	3.1	3.8	3.5	1.3	1.4	1.4	9	8		
University webometrics ranking in Kenya	2	2									40.	36.	37.1
	1	3	44	2.7	3.3	3.0	1.1	1.2	1.2	7	4		
Total number of stakeholder conferences held	2	2									38.	36.	
	1	3	44	3.4	3.6	3.5	1.3	1.3	1.3	2	1	37.1	
Total number of collaborative activities with other institutions held	2	2									41.	33.	
	1	3	44	3.4	3.6	3.5	1.4	1.2	1.3	2	3	37.1	
Total number of industry visits made	2	2									38.	36.	
	1	3	44	3.4	3.8	3.6	1.3	1.4	1.3	2	8	36.1	
Total number of	2	2	44	3.5	3.8	3.7	1.4	1.4	1.4				

guest speakers hosted	1	3									40.	36.	37.8
											0	8	
Performance of our university has greatly increased over the past five years	2	2									35.	28.	
	1	3	44	3.4	3.9	3.7	1.2	1.1	1.2	3	2	32.4	
Average	2	2									39.	34.	
	1	3	44	3.3	3.7	3.5	1.3	1.2	1.3	0	2	36.3	

*Key: pu-public universities; pr-private universities; Co-combined (all universities)*

Table 1.5 shows that private universities performed better (mean score of 3.7 out of 5) compared to public universities (mean score of 3.3 out of 5). The overall mean score of university performance for both public and private universities is 3.5 out of 5 with the lowest score of 3.0 for webometrics ranking. Private universities have lesser variability in all performance indicators compared to those of public universities. This demonstrates that the responses on performance from private universities were more consistent and better than public universities. Among public universities, responses on net surplus were the most consistent with smallest variability of 35.3% and largest variability of 42.4% in total number of students. Among private universities, responses on net surplus were also the most consistent with smallest variability of 28.9% and largest variability of 37.1% in total number of students. When the universities are combined, responses on net surplus remained the most consistent with the smallest variability of 30.6% and largest variability tied at 40% in supervisor to student ratio. The findings imply that net surplus is the most stable indicator of university performance.

*Table 1.6: Independent Samples t Test for Equality of Means on University Performance*

Variable	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Net surplus	-1.025	42	.311	-.35404	.34557	-1.05142	.34334
Total amount of scholarship awards or grants for students	-.101	42	.920	-.03727	.36854	-.78102	.70648
Total number of Students	-.469	42	.642	-.18841	.40173	-.99912	.62231
Supervisor to Student ratio	-1.592	42	.119	-.63975	.40194	-1.45090	.17140
University webometrics ranking in Kenya	-1.751	42	.087	-.59420	.33938	-1.27909	.09069
Average	-	-	-	-	-	-	-
	0.8234	42	0.472364		0.3835	-1.08412	0.46375
		5		-0.31018			5

The mean scores for the indicators of University performance were compared by computing independent sample t statistic for equality of means at 95% level of confidence and 42 degrees of freedom to test the significance of the difference between sample means of private and public universities. As shown in table 1.6, values of independent sample t-test are negative i.e. less than 2.5 and all p values are greater than 0.05. It is therefore concluded that there is significant difference in performance between public and private Universities.

*Correlation and Regression Analyses between Curriculum Orientation and University Performance*

Correlation analysis was done after aggregating the variables as composite indices. When Pearson’s product moment correlation coefficient (r) was computed, it was established that there exists high positive correlation between curriculum orientation and University performance since  $r = 0.895$ , which is greater than 0.7. The correlation is significant at p value  $(0.000) < 0.05$  as shown in Table 1.7

**TABLE 1.7: CORRELATIONS BETWEEN CURRICULUM ORIENTATION AND UNIVERSITY PERFORMANCE**

		University Performance
University Performance	Pearson Correlation	1
	Sig. (2-tailed)	
	N	44
Curriculum Orientation	Pearson Correlation	.895**
	Sig. (2-tailed)	.000
	N	44

\*\**. Correlation is significant at the 0.05 level (2-tailed).*

Correlation coefficients between curriculum orientation indicators and University performance were further analysed as shown in table 1.8. Results show strong positive correlations between each indicator and University performance. Stakeholders’ engagement and University performance demonstrates the strongest positive correlation among other variables, at  $r = 0.919$  and p value less than 0.05.

**TABLE 1.8: CORRELATIONS BETWEEN CURRICULUM ORIENTATION INDICATORS AND UNIVERSITY PERFORMANCE**

		University Performance
University Performance	Pearson Correlation	1
	Sig. (2-tailed)	
	N	44
Frequency of Curriculum Review	Pearson Correlation	.868**
	Sig. (2-tailed)	.000
	N	44
Stakeholders' Engagement	Pearson Correlation	.919**
	Sig. (2-tailed)	.000
	N	44
Professional Bodies Engagement	Pearson Correlation	.864**
	Sig. (2-tailed)	.000
	N	44

\*\**. Correlation is significant at the 0.05 level (2-tailed).*

When each of the indicators of curriculum orientation was regressed with University performance, stakeholders' engagement (S) was found the most significant predictor of University performance (Y) with p value =0.003< 0.05 followed by curriculum review (R) with p value =0.041, still less than 0.05. The last was Professional bodies' engagement (P) with p value 0.049< 0.05. From Table 1.9, the regression model relating each curriculum orientation and University performance can be expressed as  $Y=0.49 +0.3S +0.22R+ 0.13P$ . The model implies that a unit percentage increase in stakeholders' engagement (S) would cause 0.3% increase in University performance (Y), a unit percentage increase in curriculum review (R) would cause 0.22% increase in University performance (Y) and a unit percentage increase in Professional bodies' engagement (P) would cause 0.13% increase in University performance (Y). ANOVA values show that  $F(4, 39) = 73.531$  and p value (0.000) < 0.05, tolerance values >0 and most VIF values <10,

thus the regression model is a valid relationship between curriculum orientation and University performance.

**TABLE 4.26: REGRESSION SUMMARY AND ANOVA ON LINKAGE STRATEGIES-PERFORMANCE**

	Standardised		Sig.	R		df	Sig.	Collinearity		
	Coefficients	Beta		R	Square			F	Statistics	
Regression				.940 <sup>a</sup>	.883	73.531	4	.000 <sup>a</sup>	Toleranc	VIF
Constant	.49		.00			Residua	39		e	
Frequency of Curriculum Review	.04	.220	.04					0.078		10.1
Stakeholders' engagement	.12	.300	.00					0.144		6.92
Professional bodies' engagement	.12	.130	.04					0.181		5.51

*Regression model is significant at the 0.05 level (2-tailed).*

Consequently, all the four formulated hypotheses were accepted as follows:

**Hypothesis 1:** *There is a significant positive correlation between curriculum review and University performance.*

**Hypothesis 2:** *There is a significant positive correlation between stakeholders' engagement in curriculum development and University performance.*

**Hypothesis 3:** *There is a significant positive correlation between professional bodies' engagement in curriculum development and University performance.*

**Hypothesis 4:** *There is a significant joint effect of curriculum orientation on University performance.*

### **Discussion**

Correlation analysis indicates that there exists high positive correlations between curriculum orientation and University performance. This demonstrates that strategic choices with strong industry linkage components yield superior organizational

performance while strategic choices with weak industry linkage orientation lead to poor organizational performance. The study highlights the most significant components of curriculum orientation that impacts on University performance. Frequency of curriculum review, stakeholders 'engagement and professional bodies' engagement have been established as significant predictors of University performance. The University authorities must therefore strategically link these indicators to the industry needs by involving stakeholders and professional bodies in decision making process in order to realise superior performance. Organisational policies should take into consideration, the needs and demands of the industry that it serves rather than focus on performance in isolation. Curriculum development and review policies, industrial attachment policies and all other linkage strategies and procedures must provide space for contributions from stakeholders. There is need for University authorities to develop policies that promote collaborative curricula development in Universities. The outcome would be curriculum that is relevant to industry needs in Kenya and other African countries. Results of this study show that curriculum review is not consistent in most Universities. This implies that there is inadequate government effort in coordinating the development of academic programmes offered in these institutions to make them respond to the country's development challenges. Universities need to adopt robust policy framework to monitor industry signals and determine appropriate value weightings on some academic programmes so as meet the economic sector shortages. It is clear from the findings that some Universities do not regularly review their curricula after every complete cycle. This has a definite impact on the quality of graduates as reflected in the performance of such universities. Robust policies and implementation strategies that address curriculum development and review focus are necessary to improve the quality of graduates from such curricula. Chatterton and Goddard (2001) Studied 35 universities in Britain to investigate the use of the resource based view and knowledge based view to improve the understanding of the process for the initiation and function of University and industry collaboration. Findings confirmed the persistent lack of an integrative framework for the management of collaborations and proposed a model for University and industry collaboration. These findings agree on the fact that curriculum orientation is paramount in determining University performance. Generally, private universities recorded stronger

scores in most variables compared to public Universities as analysed in descriptive statistics. The coefficients of variation values are favourably lower among private Universities, thus indicating more consistency and stability in variable scores. It is clear from the findings that Universities can only remain relevant if they respond promptly to the changing technology and emerging industry demands, by formulating industry based curriculum development and review policies in order to counter competition challenges and strive to attain and maintain a competitive edge over the rivals in all areas of operation and more so offer quality education that is relevant to the needs of the industry.

### **Implication of the Study**

The study findings have theoretical, practical and policy implications for future researchers, University authorities and all stakeholders. Resource-based view (RBV) as the main theory anchoring the study provides a favourable model for analysing the appropriate strategies that can provide effective curriculum orientation to industry needs. Although private Universities seem to have performed better than public ones, there is need to foster more collaborative approaches in curriculum development and review across all Universities in order to exploit the synergistic benefits. For practice, the study highlights the most significant components of curriculum orientation that impacts on University performance. Although Stakeholders' engagement came out as the strongest determinant of University performance, professional bodies and regular curriculum review are equally important in ensuring that the content meets the general expectations. The University authorities must therefore strategically link these indicators to the industry by involving stakeholders in strategy formulation and implementation process, in order to come up with effective industry based curriculum development and review policy. The Universities' decision makers should therefore reinforce stakeholders' engagement as a critical component of curriculum orientation. All-round curriculum must be established in all disciplines to raise the quality of higher education, in particular, and of social life, in general. Universities must seek to acquire resources to support academic staff travel for participation in professional conferences and training programmes. It is important that there be serious consideration of investment in curriculum development and review that will enhance the capacity of universities in the region in order to further national development. Organisational policies should take into consideration, the needs and demands of the industry that it serves rather than focus on performance in isolation. Curriculum development and review policies should be built around improving the fit between higher education and the world of work and making institutions more cost-effective. University curricula are often disconnected from industry needs. There is therefore, need to review the legal framework, protocol and conventions that set up these institutions to allow for more collaboration with the universities and industry players. There is need to establish a national policy on university-industry collaboration on curriculum development and promotion of innovative knowledge transfer mechanisms.

This would involve development of policies for creating spin-off companies to utilize university patents and licenses and establishment of IPR management offices in each university and support the establishment of joint university-industry incubation centers. Future studies should be undertaken in Kenya and the East African region using relevant data from a variety of media sources and for longer periods of time. Particularly, it is recommended that regular surveys should be conducted by stakeholders including relevant government departments and universities to specifically seek opinions of prospective employers on what academic programmes and specific skills they consider critical for various jobs. Regular surveys need to be undertaken to obtain perceptions of University students on various jobs and industry. Such studies shall produce information that would inform curriculum development process among Universities so as to make higher education in Kenya more relevant to the country's current and future development needs.

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# **Innovative Approaches to Higher Education and Training for Sustainable Quality and Standardization of University Education for Sustainable Development in Kenya**

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## **ABSTRACT**

Education is a key for better life and effective foundation for smooth operations of person's lifetime. In the recent times university education is becoming irrelevant for hiring the individuals, in organizations and industries both locally, nationally and internationally. This is due to graduates from unfettered proliferation of Satellite University campuses in almost every town in Kenya churning half baked graduates. The problem is the commercialization and politicization of higher education leading to poor standards and quality education leading churning out unemployable graduates trained courses which are unresponsive to market needs and industrial attraction. The objective is to investigate whether the satellite campuses offer courses with quality and standards. The paper employs a survey method and data collected through questionnaires from students in satellite campuses in Kitale town through simple random sampling. The research paper target a population of 500 and 30% sample size. The key results shows that there is poor standards in satellite campuses because part time lecturers are not paid on time and wait for three years and lead to de-motivation as a consequence of poor teaching and supervision of students. Some lecturers do not submit the marked scripts and the management manipulate grades for students to graduate. There is insufficient and dilapidated infrastructure, boated enrolment, nepotism, tribalism and poor quality education offered in satellite campuses. It is concluded the emergency of university satellite campuses has led to poor quality and standards in universities leading to half-baked and unemployable graduates though having attractive grades. The research paper recommends innovate approaches should be used for education reforms and restructuring be done in satellite campuses for sustainable education development inline with vision 2030. The satellite campuses should be allowed to operate if they have enough and full time qualified teaching staff and finances, without which standards of higher education will remain poor in Kenya.

**Key words:** Commercialization, education, politicization, quality, standards

## **Introduction**

Tracing the quality and standards of university education in Africa, historical evidence indicates that the quality and standard of education was highly valued in Africa. However, as in other parts of the world, literacy in Africa was connected with religion, so that in Islamic countries, it was a Koranic Education, and in Christian Ethiopia, the

education was designed to train priests and monks. In Egypt, there was the Al-Azhar University, in Morocco, the University of Fez, and in Mali, the University of Timbuktu—all testimony to standard of education achieved in Africa before the colonial intrusion (Rodney, 2015:223). Quality and standards of education in Kenyan universities is low due to the fact that the lecturers embark only on the teaching pillar and forget about other pillars of research and community outreach. The part-timers have no time in research due to the fact of their deplorable financial state resulting into being unable to research and publish. There is evidence that universities have gone teaching without involving students in research and community outreach. In the early university was of a high quality and standards were maintained because lecturers involved students in doing research and publication. Many of the monographs and articles for Departmental teaching were prepared and published by the lecturers through the researches conducted by their students in Makerere University, University of Nairobi and Dar-es-Salam University. These universities had a balanced standards and quality education in three pillars of the university education that is teaching, research and Community/public outreach, that is why they were outstanding and popular in East Africa, Africa and the whole world and enabling students exchange programmes.

Universities in Kenya in early sixties to late nineties were known as *Ivory towers* in education. Those who received the higher education were known to be “academic community”. The academic community to come down from the *ivory tower* is really a challenge. As Ki-Zerbo observed “there is very little use to have African academics living like home-grown clones of foreign technical and personnel, the kind of person ordinary people cannot identify with” (Ki-Zerbo, 1994:36). Similarly Ochola (2007:101) connotes that it has correctly been observed that “African universities stand as vital organs in the institutional framework of the nation” (Hagan, 1994:46). As Hagan (1994) noted, “not to provide support for the development of the university would compromise and deny the one means by which Africa can develop intellectually, socially and materially”. Therefore, in the context of African university development requirements, the university teachers have basically two mandates. The first, for which they are paid, is to advance the frontiers of knowledge and produce trained personnel, who not only pursue their own individual interests, but also that of the society at large. This requires

the academics to devote their time in activities of public education. The second and due to the scarcity of professionals in Africa, is to assist in search for, and the creation of well founded institutions, sound public policies and scientific management practices that can sustain development (Ochola, 2007:101).

It is quite unfortunate to get the university professors in the management frustrate the part time lecturers by non-payment for three years and yet they know the difficulties of dissemination of knowledge and skills to others. “University” means any institution or centre of learning by whatever name called, or however designated, having as one of its objects the provision of post-secondary education which intends to offer or is in fact offering courses of instruction leading to the grant of certificates, diplomas and degrees, and the expression “university education” shall be construed accordingly (Kenya Education Directory,2012). University: according to Webster’s New Twentieth century Dictionary, a university is an educational institution of the highest level, typically with one or more undergraduate schools or colleges, together with a program of graduate studies and a number of professional schools and authorized to confer various degrees, as the bachelor’s, master’s and doctor’s. University education refers to education provided by universities in qualitative training in relevant fields according to the current market demands. Therefore, University education is associated with better skills, higher productivity and enhanced human capacity to improve the quality of life in societies. University education as an institution is where graduates are being churned to possess not only technical skills but must have the soft skills and other knowledge skills required, referred to as the intellectual battle.

Education is a key for better life and effective foundation for smooth operations of person’s lifetime. But in the recent times university education is becoming irrelevant for hiring the individuals, in organizations and industries both locally, nationally and internationally. This is due to graduates from unfettered proliferation of Satellite University campuses in almost every town in Kenya churning half baked graduates. In this aspect, a satellite campus refers to an institution located in a town, managed and operations are done by a director and two or three administrators appointed by Mother University and several non-teaching staffs on contract basis and large numbers of part time lecturers. Public universities do not give contract letters to part time lecturers to

demand for their rights that is why, they distance themselves and unable to protest, and cannot sue the university management (Okebiro, 2017). Part time lecturers are unable to take the university management to court, because a great number of them do not have letters of contract with their universities. And since part time lecturer's union of Kenya (PTLUK) was not registered and was operating illegally, the officials had no mandate on behalf of the lecturers (Weekly Citizen, February, 2016). In the pre colonial period, according to Professor Indiatsi Nasibi, in his article "Management of universities a mockery of devolution", one campus had thousands of teaching staff with tutorial fellows who assisted professors marking papers and scripts (Daily Nation, May 19<sup>th</sup>, 2013).

Universities in Kenya maintained one campus for example university of Nairobi, Kenyatta, Egerton, Moi, Jomo Kenyatta universities for some period before 1990s. This was an indication of quality lectureship professorship and quality standards in university education as compared to modern Kenya where a university is given a charter within two years begins to open branches without even maintaining the quality of the main campus alone in terms of qualified lecturers and other resources in teaching. Okebiro (2016) observes that "provision of quality education is dependent on more than teachers/lecturers and classrooms/lecture theatres, but the duration or period on which the content in the curriculum is covered". The quality of the content taught, the materials used to teach it and the skills that are developed are too of great significance (Okebiro, 2016). Staffing in universities is overstretched because there is the mismatch workforce and personnel to staff the increasing mass of students.

### **The statement of the problem**

The problem is the commercialization and politicization of higher education leading to poor standards and quality education leading churning out unemployable graduates trained courses which are unresponsive to market needs and industrial attraction. Many scholars have decried the dearth of proper research and deterioration of quality of learning in most public universities. The financial health of most public universities has been questioned with many accused of misappropriating funds or over borrowing to run universities. They also have been accused of fueling negative ethnicity by hiring staff not necessarily based on merit and competence but on tribalism and corruption, which is unacceptable as diversity should help enhance quality and standard of learning in

universities. Further, there is duplication of degree programmes across universities and mushrooming of what is termed as “Lollipop degree programmes, which undermine the very essence of university education of offering quality and standard education. A lollipop degree as the name suggests is alluring, trendy, both sexy and sexualized, thin in content and possessing the barest of “nutritive”(intellectual and possibly employment) dividends.

### **The objectives of the research**

The objective is to investigate whether the satellite campuses offer courses with quality and standards.

### **Literature Review**

There was no university education in East Africa until 1949 when Makerere College in Uganda was elevated to the status of the University College of East Africa (Bogonko, 1992). University education up to then was received in overseas or foreign countries. First, this means those who were able financially and favored by the colonial government, their children were allowed to go and receive university education and it was financed by the colonial government. Second, those who received university education in foreign land, either their parents collaborated with the colonial government or were supportive in one way or the other to colonial system. Third, because of few people were qualified to receive such education and the colonial government could not allow, Africans feared to go to school to get primary and intermediate education to qualify for university education.

The period of Makerere College 1949 to 1961, the university education was financed by the colonial government. In 1961 two other colleges, Nairobi and Dar- es- Salaam were established and 1963, the three colleges were amalgamated to form the University of East Africa. The three colleges became independent universities in 1970, as Makerere University in Uganda, Dar es Salaam in Tanzania and university of Nairobi in Kenya (Bogonko, 1992).

University education was not in great demand, because few people could cope with education system in colonial system. Makerere University was the only in East and Central Africa and offered a few courses for the students from the region. When the demand for higher education grew, Makerere had to expand and open branches in Dar-es-

salam in Tanzania and Nairobi in Kenya to meet demand goals. Those who had money travelled to overseas to acquire higher education in U.S.A, Canada, U.S.S.R, India, Jamaica, Australia and United Kingdom. This “flight education” was necessary, because the capacity of East African Universities could not cater for high demands of students. Nowadays universities have been located everywhere in Kenya, both public and private. Malcolm Gills, the president of Rice University back in 1999, noted that “Today, more than ever before in human history, the wealth or poverty of nations depends on quality of higher education. Those with larger repertoire of skills and a greater capacity for learning can look forward to lifetimes of unprecedented economic fulfillment. But in the coming decades the poorly educated face little better than the dearly prospects of lives of quiet desperation”.

Educational development refers to skills and knowledge acquired by people without any region being marginalized. Kenya intends to create globally competitive and adaptive resource base to meet the requirement of a rapidly industrializing economy. This will be done through life-long training and Education, (Vision 2030). According to Mutheu (2012), human capital is now estimated to be three times more than important than the physical capital. Where does this human capital come from? It is developed at higher systems and for there to be higher quality education system with tertiary education providing advanced skills, which command a premium in today’s work place. Lifelong learning is being used to assist workers adjust to the quadruple changing economies globally. According to Chambers (2005), participation concerns mutual learning, in which participation is an epistemological and practical issue of understanding where others are coming from and ideally, learning from one another to achieve a better outcome. A university has changed perceptions in the area and simplified dry land for farming through extensive research by the university (The Standard August 16, 2013).

The universities between 2013 and 2016 tried to fill the gap left by the government funding by opening campuses all over the place in towns in Kenya, sometimes next to pubs, strip club, and doomsday churches without taking care of the quality teaching and learning(Sunday Nation, March 11,2018). The opening of the campuses by universities gave other universities impetus to open so that to make money. According to Prof. Maloba Wekesa “the competition to open campuses and village shoeshine universities is

never about excellence, most of those colleges are just income-generation projects and degree mill centers especially for politicians” (Sunday Nation, March 11,2018),and an avenue for the university managers to built estates and a source of employing their family members and relatives. Therefore the universities adopted neoliberal policies that view everything in terms of profits have hit the universities where it hurts.

It is noted that “Academics have bought into the lie that the way to run universities efficiently is to run them as profit-making business, but education is totally different kind of organization where people invest in people, thus the teaching staffs in universities are accountable for the people they teach and the people of the society. The high standards have been set in primary and secondary school examinations, by the Cabinet Secretary in the Ministry of Education.. Therefore, the university senates are urged to emulate efforts made in elevating credibility of examinations in basic education institutions. It is important to note: how can those students come to universities to get lower examination standards? The senates as custodian of education standards in universities must make the lead role in ensuring examinations are credible and students get marks they deserve (Sunday Standard, November 26<sup>th</sup>, 2017).

According to Prof.Amutabi, “Some universities have established ethno-centralism culture where some people think universities belong to them because they bear their ethnic name or located in their counties” (Sunday Nation, March 11,2018), and continue to compromise the quality and standards of education because they are packed by the regime ruling the country. This is because, intellectuals who claim to be neutral towards each regime, sell themselves cheap to every regime that comes to power and support every status quo. Some were happy to support the status quo for the sake of careers and preiviliges that go with those institutional positions (Ochola, 2007:106).

As Ochola argues “the African intellectuals themselves must have also bear a great share of the blame and responsibility for the present deteriorating situation” (Ochola,2007:106), because the cohort of part-time lecturers are unpaid for long periods of time at least three years which is dangerous for the quality services offered to the learners in such institutions. Okebiro argues “he excellent In-put from a lecturer reflect excellent out-put of the students through competence in the labour market” (Okebiro, 2014). According to Okebiro (2014), the university management has unfair academic treatment of associate

lecturers/part time lecturers as regards to borrowing textbooks from library, payments and other benefits in the university. Part time lecturers are core and key in the teaching pillar in universities and if they cannot be treated well, they would equally offer poor services and as a consequence compromise the standards of education, which is a source of sustainable university education and societal empowerment.

### **Methodology**

The paper employs a survey method and data collected through questionnaires from students in satellite campuses in Kitale, Eldoret and Nakuru towns through simple random sampling. The research paper target a population of 500 and 30% sample size. The study used a survey research design on the satellite campuses in Kitale town. Mugenda and Mugenda (2003) noted that surveys are the excellent vehicles for the measurement of characteristics of large population. The design was appropriate because it helped the researcher to obtain information that describes phenomenon by asking individual students and lecturers about their perceptions, attitudes, behaviour or values related to the quality and standard of education in the campus. This study used a research method where descriptive statistics were employed in analyzing the data through percentage in tables. Data was collected from 150 students and 422 lecturers both full time and part time. The questionnaires are attached in appendix I and II.

### **The key findings**

The study investigated whether the satellite campuses offer courses with quality and standards. The respondents' views on quality and standards of education were investigated using Likert-scaled questionnaires administered to both the students and lecturers. Data was analyzed and interpreted as illustrated in table 1.

Table 1: Descriptive Statistics and Views of students on standard and quality of education in campus

<b>Item</b>	<b>SA</b>	<b>A</b>	<b>U</b>	<b>D</b>	<b>SD</b>	<b>Mean</b>	<b>Std. Dev.</b>
There are enough qualified part time lecturers teaching course units	53 (33.8	64 (40.8	14 (8.9%)	21 (13.4	5 (3.2%)	3.89	1.11

There is enough lecture theatres for teaching or lecturing	53 (33.8)	79 (50.8)	13 (8.3%)	10 (6.4%)	2 (1.3%)	4.09	0.88
There are no text books for reference in every course unit	53 (33.8)	71 (45.2)	20 (12.7)	10 (6.4%)	3 (1.9%)	4.03	0.94
Lecturers attend lectures at the appropriate time for lecturing always	30 (19.1)	61 (38.9)	38 (24.2)	21 (13.4)	7 (4.5%)	3.55	1.08
The lecture theatres are NOT free from noise pollution in the campus	58 (36.9)	72 (45.9)	14 (8.9%)	10 (6.4%)	3 (1.9%)	4.10	0.94
The lecturers cover the course content in the course outline in the right time	69 (43.9)	65 (41.4)	12 (7.6%)	7 (4.5%)	4 (2.5%)	4.20	0.94
The lecturers DO NOT administer two Continuous Assessment	96 (61.1)	47 (29.9)	7 (4.5%)	6 (3.8%)	1 (0.6%)	4.47	0.80
The campus DOES NOT offer sciences courses because there are no	67 (42.7)	57 (36.3)	12 (7.6%)	17 (10.8)	4 (2.5%)	4.06	1.08
The lecturers mark continuous assessment tests(CATs) and	49 (31.2)	75 (47.8)	19 (12.1)	9 (5.7%)	5 (3.2%)	3.98	0.97
Students are less than fifteen in	41 (26.1)	52 (33.1)	26 (16.6)	25 (15.9)	13 (8.3%)	3.54	1.25

Key: SA-Strongly Agree, A-Agree, U-Undecided, D-Disagree, SD-Strongly Disagree and Std. Dev.-Standard Deviation

There are enough qualified part time lecturers teaching course units in this sense the respondents give the following information: 64 (40.8%) of the students agreed, 53 (33.8%) strongly Agree that there are enough qualified part time lecturers. 21 (13.4%) of the respondents disagree and 5 (3.2%) strongly disagree while 14 (8.9%) were Undecided. This means the education is not treated as a “public good” and a profit-making venture, the university management and stakeholders will use different approach where the bigger-size classes taught by part-time lecturers to avoiding spending money on faculty stability and quality education. The cohort of part-time lecturers are unpaid for long

periods of time at least three years which is dangerous for the quality services offered to the learners in such institutions.

There is enough lecture theatres for teaching or lecturing 79 (50.8%) agree and 79 (50.8%) strongly disagree. 10 (6.4%) disagree and 2 (1.3%) strongly disagree and 13 (8.3%) undecided. A mean of 4.09 and the standard deviation of 0.88. This implies students enjoy the teaching and learning.

There are no text books for reference in every course unit 71 (45.2%) agree and 53 (33.8%) strongly disagree. 10 (6.4%) disagree and 3 (1.9%) strongly disagree and 20 (12.7%) undecided, a mean of 4.03 and standard deviation of 0.94. This indicates that satellite campuses are ill equipped with text books for reference. This makes students to be unable to do research for assignments and writing researched term papers.

Lecturers attend lectures at the appropriate time for lecturing always: 61 (38.9%) agree and 38 (24.2%) undecided 30 (19.1%) strongly agree and 21 (13.4%) disagree and 7 (4.5%) strongly disagree and a mean of 3.55 and standard deviation of 1.08. It shows that lecturers work effectively but the management fail to pay their dues in the right time.

The lecture theatres are NOT free from noise pollution in the campus: 72 (45.9%) agree and 58 (36.9%) strongly agree whereas 14 (8.9%) are undecided and 10 (6.4%) disagree and 3 (1.9%) strongly disagree, a mean of 4.10 and standard deviation of 0.94. This indicates that the satellite campuses are located where there is noise from the strip clubs, pubs and welding workshops.

The lecturers cover the course content in the course outline in the right time: 69 (43.9%) strongly agree and 65 (41.4%) agree, 12 (7.6%) undecided and 21 (13.4%) disagree and 4 (2.5%) strongly disagree, a mean of 4.20 and standard deviation of 0.94.

The lecturers DO NOT administer two Continuous Assessment Test (CATs): 96 (61.1%) strongly agree, 47 (29.9%) agree and 7 (4.5%) undecided whereas 6 (3.8%) disagree and 1 (0.6%) strongly disagree, a mean of 4.47 and standard deviation of 0.08. This illustrates the fact that most of the part time lecturers DON'T have time to administer CATs instead they prefer giving assignments and take away cats which are lecturer-student friendly.

The campus DOES NOT offer sciences courses because there are no laboratories for

practical tests: 67 (42.7%) strongly agree and 57 (36.3%) agree and 17 (10.8%) disagree and 12 (7.6%) undecided and 4 (2.5%) strongly disagree, a mean of 4.06 and standard deviation of 1.08. This indicates that the satellite campuses are for profit making courses which do not need practical especially physics, chemistry and biology courses. Those undecided and disagree and strongly disagree are the ones who apply and promised that the courses are going to be offered soon.

The lecturers mark continuous assessment tests (CATs) and assignments on time and return the marked scripts to the students: 75 (47.8%) agree, 49 (31.2%) strongly agree, and 19 (12.1%) undecided whereas 9 (5.7%) disagree and 5 (3.2%) strongly disagree, a mean of 3.98 and standard deviation of 0.97. This shows that most lecturers are committed to their work and it is the university management which frustrates them through non payment for a long period of time.

Students are less than fifteen in course units: 52 (33.1%) agree and 41 (26.1%) strongly agree and 26 (16.6%) undecided, whereas 25 (15.9%) disagree and 13 (8.3%) strongly disagree, a mean of 3.54 and standard deviation of 1.25. This indicates there poor enrollment of students into satellite campuses and making the management unable to pay the rental bills. The universities across the world are allowed to set the standards regarding the students to be admitted into the university. The Kenyan government requires all universities including private ones to admit only students with a mean score of C+ and above in high school. In this sense only 15 per cent of KSCSE candidate attained the cut-off score last year. The number is just enough slot in public universities, leaving private universities and income-generating streams in public universities without prospective students (Sunday Nation, March 11, 2018). With dwindling enrolment numbers of students, it is very difficult for these universities to remain afloat.

The key results shows that there is poor standards in satellite campuses because part time lecturers are not paid on time and wait for three years and lead to de-motivation as a consequence of poor teaching and supervision of students. Some lecturers do not submit the marked scripts and the management manipulate grades for students to graduate. There is insufficient and dilapidated infrastructure, boated enrolment, nepotism, tribalism and poor quality education offered in satellite campuses. According to Professor Indiatasi

Nasibi,"as an employer of university trained people, the federation doubts out that our academic institutions have devolved with campuses on every street and corridor, whose focus is not accumulation of intellectual capacity, but a search for money and profitability. It is true that universities have become oblivious to the law of diminishing utility. They are oblivious of the volume of scripts the staff who are underpaid, can mark effectively" (Daily Nation, May 19<sup>th</sup>, 2013).

Table 2 gives the analysis of the data and the interpretation as follows; There are NO payments on the right time: 85 (32.1%) strongly agree and 82 (30.9%) Agree and 47 (17.7%) disagree and 26 (9.8%) undecided whereas 25 (9.4%) strongly disagree, a mean of 3.60 and standard deviation of 1.33. which illustrates that the lecturers take a long time to be paid their money and given that universities nowadays use different modes of determining payments, lecturers use their saved money until the universities becomes source of poverty instead of becoming source for unemployed part time lecturers.

There is high coverage of the course content in the right time: 127 (47.9%) agree and 79 (29.8%) Strongly agree and 30 (11.3%) disagree, 17 (6.4%) undecided and 12 (4.5%) strongly disagree, a mean of 3.90 and standard deviation of 1.06. This shows that the lecturers are prepared to teach the students in satellite campuses.

You feel de-motivated due to Non payment: 120 (45.3%) agree, 84 (31.7%) strongly agree, and 25 (9.4%) Undecided and 21 (7.9%) disagree and 15 (5.7%) strongly disagree, a mean of 3.94 and standard deviation 1.05. This indicates that most of the lecturers are de-motivated when unpaid and cannot give qualitative services because of hunger.

There NO text books for reference in some course units: 80 (30.2%) agree and 56 (21.1%) strongly agree, 53 (20.0%) undecided, 46 (17.4%) disagree and 30 (11.3%) strongly disagree, a mean of 3.40 and standard deviation of 1.23. This illustrates that there are no test books in the library and this leads to poor research and students are depressed because unfounded materials and relies on goggling notes from the internet.

Lecturers have NO lecturers parlor for preparation: 109 (41.1%) agree, 91 (34.3%) strongly agree, 28 (10.6%) undecided, 22 (8.3%) disagree and 15 (5.7%), a mean of 3.93 and standard deviation of 1.10. This shows that lecturers do not prepare adequately before going to lecturer. some lecturers prepare from corridors in satellite campuses or from the

public vehicles before highlighting.

Lecturers DO NOT assess learners in Teaching Practice (TP) and attachment assessments for students in education and social sciences: 139 (52.5%) agree, 98 (37.0%) strongly agree, 11 (4.2%) undecided, 9 (3.4%) disagree and 8 (3.0%) strongly disagree, a mean of 4.20 and standard deviation of 0.84. This illustrates that teaching professionalism is not followed. The assessors who assess students are different, compromising the quality and standard of teaching practice. A teacher trainee is supposed to be assessed three times by the lecturer who taught general methods of teaching and two lecturers taught the major and minor subjects of specialization for the teacher trainee.

Table 2: Descriptive Statistics and Views of lecturers on the quality and standard of education in the campus

Item	SA	A	U	D	SD	Mean	Std. Dev.
There are NO payments on the right time	85 (32.1%)	82 (30.9%)	26 (9.8%)	47 (17.7%)	25 (9.4%)	3.60	1.33
There is high coverage of the course content in the right time	79 (29.8%)	127 (47.9%)	17 (6.4%)	30 (11.3%)	12 (4.5%)	3.90	1.06
You feel de-motivated due to Non payment	84 (31.7%)	120 (45.3%)	25 (9.4%)	21 (7.9%)	15 (5.7%)	3.94	1.05
There NO text books for reference in some course units	56 (21.1%)	80 (30.2%)	53 (20.0%)	46 (17.4%)	30 (11.3%)	3.40	1.23
Lecturers have NO lecturers parlor for preparation	91 (34.3%)	109 (41.1%)	28 (10.6%)	22 (8.3%)	15 (5.7%)	3.93	1.10
Lecturers DO NOT assess learners in Teaching Practice(TP) and attachment assessments for students in education	98 (52.5%)	139 (37.0%)	11 (4.2%)	9 (3.4%)	8 (3.0%)	4.20	0.84
Lecturers mark the examinations and return the scripts with mark sheets	138 (52.1%)	100 (37.7%)	14 (5.3%)	9 (3.4%)	4 (1.5%)	4.37	0.82
There is noise pollution from outside the surrounding environment in the	139 (52.5%)	86 (32.5%)	15 (5.7%)	17 (6.4%)	8 (3.0%)	4.29	0.95

The students have No sports grounds for games	92 (34.7%)	106 (40.0%)	29 (10.9%)	26 (9.8%)	12 (4.5%)	3.92	1.10
Students attend the lectures regularly	62 (23.4%)	112 (42.3%)	57 (21.5%)	14 (5.3%)	20 (7.5%)	3.71	1.08

Key: SA-Strongly Agree, A-Agree, U-Undecided, D-Disagree, SD-Strongly Disagree and Std. Dev.-Standard Deviation

Lecturers mark the examinations and return the scripts with mark sheets: 138 (52.1%) strongly agree, 100 (37.7%) agree, 14 (5.3%) undecided, 9 (3.4%) disagree and 4 (1.5%) strongly disagree, a mean of 4.37 and standard deviation of 0.82. This indicates that the lecturers express professionalism in their work.

There is noise pollution from outside the surrounding environment in the campus: 139 (52.5%) strongly agree, 86 (32.5%) agree, 17 (6.4%) disagree, 15 (5.7%) undecided, and 8 (3.0%) strongly disagree, a mean of 4.29 and standard deviation of 0.95. This indicates that the satellite campuses are located in environment not good for learning and teaching as a result compromise quality of education offered to students.

The students have No sports grounds for games: 106 (40.0%) agree, 92 (34.7%) strongly agree, 29 (10.9%) undecided, 26 (9.8%) disagree and 12 (4.5%) strongly disagree, a mean of 3.92 and standard deviation of 1.10. This shows that the students can not train in the affective and psycho-motor domains in the satellite campuses. This true because the campuses are located in storey floor of storey building were sports grounds cannot be constructed except the in door games.

Students attend the lectures regularly: 112 (42.3%) agree, 62 (23.4%) strongly agree, 57 (21.5%) undecided, 20 (7.5%) strongly disagree and 14 (5.3%) disagree, a mean of 3.71 and standard deviation of 1.08. This illustrates that students are seriously yearning for standard education in universities.

There is evidence showing poor quality and sub-standard education in Kenyan universities. Recently the university students testified to the cabinet Secretary in the Ministry of Education that they are half baked. They accuse universities of not assigning

competent lecturers to teach and poor training acquired from universities as a consequence lack jobs in the labour market (Standard Digital Monday March 19<sup>Th</sup>, 2018).

### **Conclusion**

Most experts were interviewed noted that the main problem facing Kenyan universities is the mushrooming of substandard campuses. Also the rapid expansion of universities to cater for rising demand for degrees from the seven public universities in 2012 to 33 in 2018, it is concluded the quality of teaching and research has sunk to the lowest ebb and as consequence there a mismatch of the skills acquired and the employment. It is concluded the emergency of university satellite campuses has led to poor quality and standards in universities leading to half-baked and unemployable graduates though having attractive grades. The sites for such satellite campuses are not welcoming environment which students require for learning. They are located in the midst of the town centers where business is conducted and there is noise pollution. The library in such campuses is not equipped with the necessary books for reference in the courses taught or offered in the schools. Thus it becomes difficult for students to research and write adequate and conclusive term papers.

If the only reason for the existence of a university programme is pegged purely on vagaries of the industry, then it is most likely a lollipop degree. In essence a university education is not reducible to industry, but designed to churned intelligent brains to help solve complex problems occurring in the society. Universities are not designed to be the uncritical conveyor belts of industry trends. As the cooperation or linkage between the two must be encouraged and pursued, as both will be guided by different logics for sustainable development and economic growth in Kenya.

Many of the lecturers are not qualified to teach in the university and many are part time lecturers who are not paid on time and on the course of handling the units some drop and leave students frustrated. Usually the units are not covered extensively and intensively to cover the content required. Okebiro (2016) argues that “Education should be about producing a complete, well-rounded whole person, not just passing examinations”. It should also inculcate personal skills and skills that will be useful in the job and business world (Kigotho, 2009). According to the chief executive Institute of Certified Public Accountants of Kenya (ICPAK), Connotes “We are now being forced to ask applicants

for their secondary education certificates with the university degree coming in second,” because “The degree is no longer a reliable measure of a job-seekers ability as certain universities are churning doubtful graduates,” the faltering quality of learning is forcing employers to reject graduates from some universities (Business Daily, 2015).

It concluded that the problem facing Kenyan universities is lack of theory and conviction of leaders which is surprising, given that professors of all people should grasp the global issues facing education and what university education is supposed to contribute to the society. Kenyan university leaderships have failed to assert the uniqueness and have run the institutions as businesses. The democratization of schools should not be confused with the politicization of education. This is the only way in which our institutions of learning will be able to take the moral high ground, from which to pass the same values to society and insist that our politicians do the same. It is this role that our schools, training institutions and universities should play (Ochola, 2007:106-107).

When the governments reduce the funding the public universities which offer higher education, it has the following implications: one, performance contracting, replacing the collaborative nature of work that is collegiality and peer review with competition. Two, the measurement and evaluation of the success of the university, should be done, not by student’s enrolment, education and innovation, but by the balance sheet and real estate. Three, people are no longer interested in research but in donor funding; in some universities, donor funding is considered a major pillar of income generation. Four, generation of profit means use short cuts in education, where there are bigger-size classes taught by adjunct faculty lecturers to avoid spending money on faculty stability and quality education. Five, universities are dealing with the same dysfunctional politics as the rest of the country; promotions of faculty and graduate studies have become about ego and status rather than quality work.

The report dubbed “Transforming university Education in Africa: Lessons from Kenya” indicates that Kenyan universities require 10,000 PhDs .in some academic programmes,one lecturer teaches an average of up to 200 students against the internationally recommended 30.In most universities one professor handles up to 98 students thus compromising quality in the sense that there is no time for preparation and taking care of individual cases of students efficiently and effectively. Therefore, the

resultant capacity deficit means that quality of education is affected (Standard Digital Monday March 19<sup>Th</sup>, 2018).

### **Recommendation**

The research paper recommends innovative approaches should be used for education reforms and restructuring be done in satellite campuses for sustainable education development inline with vision 2030. It recommends two innovative approaches one indirect and two direct approaches. In the indirect approach, it is recommended return to conviction about education as a public good. First, People (stakeholders) need university leadership that believes that education is a public good and insists on it in order to resist corporatization of higher education and the implications for quality of education and research, and the better treatment of teaching staff. Second, It recommended citizenship calling for better management of public resources so that universities can be properly funded and be free for students to study without payments.

Faculty should find themselves voicing and defending education as a public good and the right of students to be offered quality and standard education in universities. The satellite campuses should be allowed to operate if they have enough and full time qualified teaching staff and finances, and enough teaching and not teaching facilities, without which standards of higher education will remain poor in Kenya. Reforms in higher education sector are urgently needed focusing on quality training and quality of education while increasing enrolment for the improvement of national development (Daily Nation, 2010).

In the direct approach, it is recommended that higher quality education should train leadership on good governance practices. “The basic needs approach (BNA)”, which was used became widely agreed that economic growth took place in most developing countries seemed to go together with increase in absolute and relative poverty. In response to, a direct approach was required to deliver the welfare outcomes. The direct approach became to be known as the basic needs approach (BNA) which drew together theorists and practitioners from a range of nations, academic centers and institutions of development (Stohr, 1981). According to Escobar (1995), the influence of BNA had ‘vast array’ of programmes focused on households and covering aspects of health, education, farming and reproduction, practices, designed to create a minimum level of welfare for

the weakest groups in society. There is need for a differentiation of institutions with some is specializing in good teaching, others in excellent research and still others providing education midway between research and teaching.

There should be radical changes in Kenya's higher education institutions of learning, which have been put on the spot over quality education. It is recommended on the direct approach, that it is time for refreshing start in institutions of higher learning to hire best brains for improving quality of learning in Kenyan universities. It is recommended; the impending staff audit should be done and would unearth the nature of the staff teaching in the universities, the stakeholders want to know whether the staff is qualified to teach their students in universities and especially those who teach first years. it is recommended first, to abolish lollipop degree programmes, there must be boldness and intellectual honesty by leaders, because degrees represent and mask peculiar kind of "Kenyan" scholarship well entrenched and addressing the problem might be seen as fighting individual's careers. Second, it is significant to rehabilitate the programmes into former disciplinary statuses-that means there will be a total overhaul of university programmes which started such degree programmes.

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APPENDIX I  
QUESTIONNAIRE FOR STUDENTS IN SATELLITE CAMPUSES

The \_\_\_\_\_ campus \_\_\_\_\_ of  
learning \_\_\_\_\_

Kindly tick( ) in the appropriate answer to the question.

Item	SA	A	U	D	SD
1. There are enough qualified part time lecturers teaching course units					
2. There is enough lecture theatres for teaching or lecturing					
3. There are no text books for reference in every course unit					
4. Lecturers attend lectures at the appropriate time for lecturing always					
5. The lecture theatres are NOT free from noise pollution in the campus					
6. The lecturers cover the course content in the course outline in the right time					
7. The lecturers DO NOT administer two Continuous Assessment					

8.The campus DOES NOT offer sciences courses because there are no

9.The lecturers mark continuous assessment tests(CATs) and

10.Students are less than fifteen in

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Key: SA-Strongly Agree, A-Agree, U-Undecided, D-Disagree, SD-Strongly Disagree and Std. Dev.-Standard Deviation

## APPENDIX II

### QUESTIONNAIRE FOR LECTURERS IN SATELLITE CAMPUSES

The \_\_\_\_\_ campus \_\_\_\_\_ of learning \_\_\_\_\_  
\_\_\_\_\_

Kindly tick( ) in the appropriate answer to the question.

Item	SA	A	U	D	SD	Mean	Std. Dev.
1. There are NO payments on the right time							
2. There is high coverage of the course content in the right time							
3. You feel de-motivated due to Non payment							
4. There NO text books for reference in some course units							
5. Lecturers have NO lecturers parlor for preparation							

6.Lecturers DO NOT assess learners in Teaching Practice(TP) and attachment assessments for students in education

7.Lecturers mark the examinations and return the scripts with mark sheets

8.There is noise pollution from outside the surrounding environment in the

9.The students have No sports grounds for games

10.Students attend the lectures regularly

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Key: SA-Strongly Agree, A-Agree, U-Undecided, D-Disagree, SD-Strongly Disagree and Std. Dev.-Standard Deviation

## **An Investigation into Factors that Contribute to Cheating in Examinations in Technical Institutions in Central Province, Kenya**

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### **Abstract**

Cheating in an examination is an act of deception by students to gain unfair advantage over others by using unauthorized materials and information. There is a significant increase in test cheating. Among those who cheat are students in technical institutions, where there is recurrence of cheating in the internal examinations. Some studies identify factors such as the following that contribute to cheating: students learning from a

dishonest society, poor teaching, poor learning environment and lack of facilities, an education system that is concerned about performance, poor time management, lack of effective study habits and technology. However, there is no readily available information on factors that contribute to cheating in technical institutions. The purpose of this study was to investigate factors that contribute to cheating in internal examinations, methods used in cheating and reasons for students to cheat; and the main aim was to devise and recommend strategies that can be applied to curb cheating in examinations in technical institutions in Central Province, Kenya. The results of the study show several factors that contribute to cheating. These are: contextual factors such as class attendance, lecturer-student interactions, poor invigilation, and lack of adequate facilities. The participants raised the following suggestions on how cheating may be curbed: strict supervision of examination, provision of adequate facilities, and frequent administration of tests and assignment. Recommendations on measures to be applied were presented along with suggestions for further research in this area.

**Key Words:** Examinations, Education, Technical Institutions, Cheating

## 1. INTRODUCTION

Technical Institutes are middle level colleges which offer technical education to students who have not obtained the minimum requirement for University admission at C+ (Session paper, 2012:10). The programmes offered take two years in certificate courses and three years in diploma courses. Students studying craft courses take shorter time since they are employed as operatives while those studying for diplomas are employed as technicians with a supervisory role (Ngerechi, 2003:4). Cheating is a form of stealing, which results in the cheater attaining recognition and grades that he or she does not deserve. It is an act of obtaining or attempting to obtain, or aiding another person to obtain academic credit for work by use of dishonest, deceptive or fraudulent means (Pavela, 1997; Blankenship & Whitley, 2000 as cited by Lambert et al., 2003, Cizek, 1999:3).

Cheating has become an epidemic in our country. According to Centre of Academic

Integrity (<http://www.academiintegrity.org>), there is a significant increase in test cheating, unpermitted student collaboration and an increased prevalence of chronic cheating. At the end of the term when the end-of-term examination marks are submitted, there are always cases of students who either cheated in the tests given during the term or at the end-of-term examination, reported. Cases of cheating are reported every term by teachers who catch students with relevant materials during continuous assessment tests (Aullo, as cited by Nyandoro, 2008:43). There are other cases of students who are not caught red-handed but reported to the principals or heads of departments through the suggestion box.

Majority of student cheaters are usually caught cheating in the subjects they perceive to be difficult (Diekhoff et al 1996; Lambert et al 2003). Students who cheat are either caught in possession of written materials in the form of crib notes, with written notes on the desks, copying from each other's work, or with formulas written on their calculators (Nyandoro, 2008:39; Adhola 2009:10). The problem is specifically rampant during the end-of-stage examination, which is administered at the end of the year in each course. Those who pass the end-of-stage examination move to the next level while those who fail are made to seat for supplementary examination or forced to repeat the course. These consequences make those who are not well prepared to cheat in order to pass and move to the next level.

## **2. PROBLEM OF THE STUDY**

Despite the fact that many institutions have examination policies that give information on consequences of cheating in examination, there has been recurrence of cheating in the internal examinations in Technical Institutions. Education by its nature and purpose is meant to teach students to be good citizens by developing in them a good character based on sound morals that would enable them to play a constructive role in their society. However, this is totally undermined when cheating in examinations is allowed to take place without serious consequences. In reality, cheating does not allow the teacher to know whether the students have understood the course content and therefore the teacher is not able to correct the gaps in student

learning by re-teaching current students and when preparing notes to teach future students (Nyandoro, 2008:17).

Cheating is very costly because of the consequences it has on all affected. Furthermore, it affects the students and the entire department's morale, and the reputation of the affected institutions as the public loses confidence in the education programmes offered in technical institutions (Nyandoro 2008:18, Knowledge,2004 as cited by Simkin & McLeod,2009:1)). It wastes time as teachers have to sit and discuss the problems associated with cheating because those caught cheating have to be dealt with (Nyandoro 2008:18; Chinamasa et al 2011:89).

Generally speaking, there has been wastage of resources for parents who end up paying extra cash when children are suspended and consequently forced to retake courses as a result of cheating( Nyandoro 2008:17; Chinamasa et al 2011:89). Students who cheat at colleges will end up cheating at their workplace when employed and when caught they will consequently lose their jobs. In conclusion, cheating has become a big challenge in many institutions and the problem is that factors causing internal examinations cheating are not well understood and as such the problem persists. It is therefore necessary to investigate the causes, nature and purpose of cheating with the aim of coming up with solutions for curbing the vice.

### 3. The objectives of the study

- (a) To determine how cheating takes place especially in the examinations in Technical Institutions in Central Region, Kenya.
- (b) To examine the methods used in cheating in the examinations in Technical Institutions in Central Region, Kenya.
- (c) To investigate the reasons for cheating in the examinations in Technical Institutions in Central Region, Kenya.
- (d) To enquire from the stakeholders into how cheating in internal examinations can be curbed in Technical Institutions in Central Region, Kenya.

#### **4. RESEARCH QUESTIONS**

- (a) What are the methods used by students to cheat in the examinations in Technical College in Central Region, Kenya?
- (b) What are the reasons that lead to cheating in the examinations?
- (c) How can cheating in the examinations be curbed?

#### **5. Methodology of the research**

The study was conducted using qualitative approach was used to help understand the meanings individuals constructed in the cheating phenomenon. Case study design of two technical institutions in central province, Kenya was adopted. Purposive sampling strategy was used due to the sensitive nature of the subject where sixteen students, 4 lecturers and 2 heads of departments were interviewed. Participant observation was used to provide detailed description of events, people, actions and objects in their settings. Document analysis of several records including crib notes and books confiscated from students, warning letters was done to complement data collected from interviews. Data from interviews was transcribed, and with the help of literature and research questions themes were identified and then data was coded, placed in categories and sub categories. The facial and content validity was achieved through the use of combined methods to provide information on the issue of cheating in examination.

This study found out various trends in examination cheating, discussed as follows:

##### **6.1 Factors that contribute to cheating in internal examinations**

From the data, several contextual factors were raised. Attendance rate both for lecturers and students was found to affect learning. On one hand, the literature posits that teachers absent from work frequently would lead to cheating in examination (Eckstein, 2003; Kathuri, 2002; Steininger & Kirts, 1964). The results of this study found that lecturers who miss classes tend to give notes to the students to copy without discussing them, ask the students to read and make their own notes. Absenteeism results in not covering all the

topics as outlined in the course content. When lecturers miss lessons, respondents felt that students would not be guided, assessed and motivated as when lecturers attended lessons. Therefore, when the examination time comes students may not be well prepared, especially that examinations are based on all topics, including those not covered in class. In order to pass the examinations, the students may plan to cheat. This supports the expectancy theory whereby students will be motivated to write crib notes, use cell phones, or collaborate in order to be able to answer questions in the examinations and subsequently pass the examination.

On the other hand, poor attendance rate of students would affect learning thus leading to cheating. When students miss lessons, especially practical lessons, they may not be in a position to answer questions in examinations, since in an examination they are expected to apply theory to practice. They usually lack understanding of concepts learnt during their absence; to avoid failure they resort to cheating in examination. One respondent felt that in case of a practical question based on a topic a student missed when it was taught, a student cannot attempt to answer such a question based on the content he or she has never seen.

The results of the study indicate that there was adequate lecturer-student interaction and as a result, cheating was discouraged. On one hand, literature supports that students cheat less when professors show a real concern, are kind, respectful and understanding to the students (Roig & Ballow, 1994; Davis & Lodvigion, 1995; Genereux & McLeod, 1995 as cited in Wikipedia webpage). One respondent (S7) stated that adequate lecturer-student interaction would discourage cheating because students are able to discuss and interact well with the lecturers and can therefore solve their academic related problems. There would therefore be no need to cheat because lecturers would have explained difficult concepts and shown them (students) how to tackle problems, thus promoting their learning. It may be said that when lecturers are approachable, students feel free to ask questions and responses to their questions improve their learning.

On the other hand, students who perceive their instructors as grumpy, callous or

unfriendly, indifferent and who do not care whether or not they learn the course materials are more likely to cheat (LaBeff et al., 1990; Diekhoff et al., 1996). The results of this study suggest that there are cases where lecturers' attitude towards students is negative and this would lead to cheating since learning in such an atmosphere is usually not effective. In such a situation the student may not internalize or absorb the course material effectively because the lecturer has no time to explain and help students in tackling questions. Students may also fear to approach such a lecturer when they have unresolved issues about topics covered. When the examination time comes, the student may realize that he or she needs to cheat in order to pass the examination.

There lies a connection between this finding and the Expectancy Theory posited by Vroom (1964). This theory proposes that an individual will decide to behave or act in a certain way because he or she is motivated to select a specific behaviour over other behaviours owing to what he or she expects the result of that selected behaviour to be (Oliver, 1974). Owing to poor performance of the lecturer in class, which led the students not understanding the subject well from the beginning, students may assume that they can only pass the examination in that subject through cheating.

According to Chinamasa et al. (2011:98) and Adhola, (2009) poor supervision of examinations and large class sizes create opportunities for students to cheat since no effective invigilation is done. Steininger, Johnson & Kirts (1964) found that invigilators leaving the room during an examination could cause students to cheat more than they would normally do. This study found that out of twenty respondents, fourteen indicated that poor invigilation is prevalent. The respondents agree that some lecturers leave the examination rooms unattended to. Others would remain in the room seated in one position, either in front of the students or at the back, throughout the examination session. They are not on the alert against what is going on in the examination room. Since students may have observed the behaviour of the invigilators for some time, they may decide whether to cheat or not, when they see who is going to invigilate their session on the timetable, depending on the strictness of the invigilator concerned.

The results of this study support both the expectancy theory and the theory of planned

behaviour. For the expectancy theory (Vroom, 1964), students who have prior knowledge that a certain invigilator is not focused when invigilating may prepare crib notes assuming they will be in a position to use them without being detected. This will help them answer questions in examination and thus lead to passing the examination without exerting much effort on their studies. The theory of planned behaviour (Ajzen, 1991) supports this sub-category in that students may have the attitude that cheating helps them to pass and that because other students cheat and have not been caught since some invigilators are neither vigilant nor keen to take action when they see a student cheating, they believe they would succeed in cheating which will help them to pass the examination. The study found there is poor invigilation of examination and that students take advantage of the opportunity to cheat in the examinations.

In addition to the above factors, the results from the study showed that provision of course outline did not inhibit cheating in examination. Eleven respondents in the study agreed that at the beginning of each term, the lecturer in charge of a certain subject issues the course outline, and that the examination is set from the topics covered within that particular term. Because the students are well aware that the examination will come only from what they have covered, it makes it easy for them to write crib notes highlighting the main points as per the topics covered in the course outline. While the course outline is meant to inform them of what they should expect within the term, it may also become a tool used as a guide to perpetrate cheating in examinations.

As it has been identified in this study, on one hand, lack of enough facilities may lead to cheating. Asuru (1996) as cited by Korbs (2009:2) contends that poor learning environment and lack of facilities are factors that influence cheating. In the study, there were two cases observed where 42 students were taking their examination in a small room. Five students shared one desk and as a result, did not have enough space to sit comfortably. This led to collaborative cheating. That class had the highest number of students observed cheating.

According to Adhola, (2009) a school environment, which is not properly arranged for

the number of students taking the examination, promotes cheating in examinations. When students are placed in such a congested environment, even those who did not have the intention to cheat may find themselves copying the work of their neighbours when stuck in a question. Lack of adequate facilities as a cause of cheating is supported by the Theory of Planned behaviour. When students know they are going to take examinations in a congested room, they may plan in advance to write crib notes with the intention of using them in the examination. They may also plan to sit in a place where the invigilator may not be able to see them when they refer to their crib notes. Others may plan to collaborate to copy from each other's work depending on how each is able to answer the questions.

On the other hand, where there are adequate facilities, and the sizes of rooms correspond to the number of students, cheating may be less, especially collaborative cheating, since students will be well spaced. The results of the study make it clear that lack of clear information on academic policy contributed to cheating in examination. According to literature reviewed institutions, which communicate effectively their policies on academic dishonesty and on common penalties, substantially reduce the amount of cheating on campus (Stuber-McEwen et al., webpage). The researcher observed that in one of the institution, three out of eight respondents did not have an idea of what the academic policy states. S6 when asked whether there is an academic policy said, "I have never heard of it" and when asked what is done to students who are caught cheating said, "I don't know". This shows that there is need to make every student aware of examination regulations as soon as they join the institution so that they can be aware of the consequences early enough. In the same institution, it was observed that there were more cases of cheating reported than in the other institution whose academic policy is well known to the students and whose penalties are severe. Therefore, it may be said that a perception of severe penalties has the likelihood of inhibiting or deterring cheating behaviour in direct proportion to perceived probability and severity of punishment.

The study found several personal characteristics contributed to cheating in examination. As it is postulated in the literature reviewed, students are more likely to cheat when they

doubt their intelligence, lack academic confidence or expect failure (LaBeff et al., 1990; Schab, 1991; Tana & Zuo, 1997 as cited by Robinson et al., 2004:2). McCabe & Trevino, (1997:380) found that students who perform poorly tend to cheat more than students who perform well. Some of the respondents agreed that when one is not sure of himself or herself, one is likely to prepare to cheat before the examination is taken. Students who are weak may cheat in examinations because they may not remember all the concepts learned in class. The pressure to get good grades in order to proceed to the next level in the course, places those students with low self-esteem, lack of self-confidence in a fix because they feel they have no ability to take up the challenge of examinations. Most of these types of students do not exert much effort on their studies as literature states. Davis and Ludvigson as cited by Bjorklund & Wenestam (1999) conclude that cheating in this case would be reduced by using positive reinforcement and by encouraging and fostering the students to acquire an outlook on life that will prevent them from cheating.

Another example from the data that assists in illustrating the value of Vroom's theory of expectancy and Ajzen's theory of planned behaviour is found in peer influence. In the data, respondents reported that students who had friends who cheated and were successful tended to follow suit. Others would cheat to compete favourably with their friends. Those who are not strong in moral values would be led astray by becoming indisciplined or abetting cheating. Although peers may influence students negatively, there were those who felt they also exercise positive influence on others by way of acting as role models, and by assisting them in their weak areas.

Those involved in extracurricular activities find themselves with less time to study and therefore, lack behind with their work and the examinations find them unprepared. They, as a result, decide to collude with their friends to cheat in the examination. The results of the study posit that as students form relationships with peers, they may develop behaviours and ways of thinking that are in keeping with these groups. The behaviour may be positive or negative thus conforming to expectancy theory and theory of planned behaviour. Two respondents felt that extracurricular activities help one become revitalized in body and mind thus students will be in a better position to understand the

course content because the brain becomes more alert when one exercises.

Report from the literature cites that two thirds of teachers believe that poor time management was the principal cause of cheating as a result of social engagement (Carroll, 2006 as cited in Wikipedia webpage). One respondent commented that students who participate in extracurricular and social activities spend the time they would have used to study away in these activities, leaving them not being prepared when examination time comes. This leads them to look for an option of cheating to pass the examinations. Students who plan their time well and start studying from the beginning of the term, perform well as they are not forced to rush to learn the content at the eleventh hour they supposed to have learnt throughout the term. There is need for students to set priorities and be disciplined so that they can better co-ordinate their activities.

Chinamasa et al. (2011:91) noted that students cheated for lack of orientation to university study methods. From the study results, it was clear that the two technical institutions did not have time set aside for students to study. There was also no lecture given to new students on how to study. Therefore it is left to the students to organize themselves on how and when to do their studies. The study shows that most students have poor study habits that hinder them from preparing effectively for their examinations. From the study, one of the reasons for cheating is unpreparedness. According to GSI (2011), ineffective or inadequate study habits influence cheating. Students lack the skills of studying that would help them retain what they have read. This study shows that most students do not read their course material until they know the examination is near thus leaving them unprepared to tackle the examination with confidence. Due to unpreparedness, students resort to cheating to pass the examinations. Most of the students in regular courses spend most of their time in social and extracurricular activities. Therefore, there is need for lecturers to counsel students from the beginning of the course to study hard and give them guidelines on how to study. There is also need for giving the schedules of tests and end of term examination so that students can prepare themselves accordingly.

From the results of the study, it was found that parents do not contribute much to cheating in technical institutions. Although they expect their children to have good grades, they do not have a great influence on the performance of the students. One respondent felt that parents would condemn cheating if they found that their son or daughter had cheated. Three respondents felt that parents would abet cheating in primary or secondary schools more than they would in tertiary institutions.

## 6.2. Methods used for cheating

The respondents identified varied methods used in cheating in the interviews for this study. The results show that use of crib notes was the most common method in cheating. The notes were written prior to the examination as S4 commented, “before doing the examinations, someone writes notes expected to come in the examinations and then you carry it to the examination room and copy answers during examinations”.

Use of cell phones was the second most common method amongst students in the two institutions as per the data collected. It was found that invigilators who understand that cell phones should not be allowed in the examination room did not remember to ask the students to switch off their cell phones and keep them away. Cell phones were used to google answers from the internet, check answers saved in the message inbox; receive messages during examination while others saved answers in their e-mail inbox. Burke et al (2007) found that electronic devices such as cell phones, iPad, electronic calculators and personal data assistants are used for smuggling in formulas and other crucial information.

The collaborative methods commonly used were copying from friends by exchanging scripts and asking for answers to a question, use of codes and discussing with friends. In technical drawing course, students checked the work of the person in front since the desks are high and slanted. Other methods used but not very common were writing on body parts, walls, and desks. Literature reviewed supports the findings of this study as stated by Franklyn-Stokes and Newstead (1995); McCabe and Trevino (1996); William (2001) and Abiodun et al. (2011:278). They listed copying from each other, assisting

each other, use of crib notes, asking for help, giraffing, and passing pieces of paper among the frequently used forms of cheating.

From the results of the study, it is clear that students plan in advance to cheat in examination and therefore prepare the materials to be used in answering examination questions. This supports the theory of planned behaviour (Ajzen 1991:181), which posits that a person's behaviour is determined by his or her intention to perform the behaviour and that this intention in turn is a function of his or her attitude toward the behaviour and his or her subjective norms. Some students may think they will not pass unless they cheat in examinations; others are driven by the knowledge that some of their invigilators are not keen to catch them while others copy their peers' work when exposed.

### 6.3. Reasons for cheating in internal examinations

The results of the study show that students cheat because they do not want to fail their examinations. Usually they fail because they were not well prepared for the examination, which happens when a student lacks the necessary ability or has failed to manage his or her time effectively. S6 commented, "They cheat because they were not well equipped and not ready for the examinations. Maybe they fear failing. They were not familiar with the course material".

Others would cheat to obtain better grades. It may be that they would like to be regarded as good or intelligent students. Crome & Marlow (1964) support this finding as they found that college students with a high need for approval cheated more often than others because they are concerned about negative evaluation should they not succeed.

The other reason for cheating given by some respondents was advancement to the next level. S3 commented that "in this school after failing you do not get your results but you are asked to repeat again another year and this is wastage of time". In the two institutions where the study was carried out, the pass mark for the end of stage examination is 40%. If a student does not attain that mark in any three subjects, their grade will be a "Fail". They are required to either repeat the whole year or move to another institution. If they

score below 40% in one or two subjects, the results show they are referred and therefore required to sit for supplementary examinations. It is only by passing the supplementary examination that they will be promoted to the next level. It is on the ground of this that students who are weak or not well prepared for the examination would resort to cheating in the examinations. The literature shows that school obsession with performance measures spurs cheating as it was found by Anderman, Griesinger & Westerfield, (1998); Waita (Daily Nation November 24<sup>th</sup> 2008: web page) and Aullo (2004).

The expectancy theory (Vroom, 1964) may be used to explain the reasons for cheating. Some students may decide to cheat because they are motivated by the prospect to pass the examination, to achieve better grades and to move to the next level thus avoiding failure.

#### 6.4. Strategies to curb cheating

During the course of the interviews, respondents were asked what they thought should be done to prevent cheating in examinations. They offered measures that should be taken by the administration, the invigilators and the lecturers throughout the course of the student's stay in the institutions. Those that occurred most frequently included: strict supervision, provision of adequate facilities, maintaining strict rules, strict class attendance, frequent administering of tests and assignments, orientation to academic policy and counselling of students as they continue with their course. Discouraging sharing of materials was mentioned by one respondent.

The study found that there was need for strict supervision of examinations. It was observed that most invigilators are not alert and actively involved when supervising an examination. When asked why lecturers are not focused when invigilating, L1 stated, "I think it takes too long and you are not doing anything for 2-3 hours, too long and you are just seated there watching students. The teacher himself or herself is not being supervised by anybody, he or she is left by himself or herself, so it is up to him or her. I also realized there is no motivation like when we do supervision for KNEC, you get nothing from it". Aullo (2004) recommends a need for lecturers to be trained on invigilation and supervision of examination. This would help them to be able to recognize the importance

of invigilation, identify signs of those cheating and be able to catch them thus inhibiting future cheaters.

There are rules that are laid down to be observed when administering an examination. The results of the study found that most invigilators do not adhere to some of these rules. Due to the fact that students know what invigilators do and not do, they are able to look for loop holes. From the study, it was observed that frisking was not done. Students were in the examination room by the time the invigilator arrived with the examination papers. Most of the respondents felt that invigilators should ensure all textbooks, note books are removed from the desks and they should check the entire room. It was agreed by most respondents that invigilators should remind students that cell phones are not allowed in examination rooms. The invigilators need to check that what is written on the desks and walls is not relevant to the particular examination being taken. As S10 commented, “students should be checked on hands, book, invigilators should be keen enough to observe students whether they have materials on them or operating their mobile phones”. When those intending to cheat realize the invigilators are thorough in their work, they may be hindered from cheating.

Three respondents identified provision of adequate facilities as being necessary during the examination period so that there would be proper spacing and lecturers have room to move around the examination room. One respondent felt that the examination officer should allocate examination rooms according to the class size. There should be enough desks and chairs so that students can be well-spaced to hinder colluding with each other and for easy supervision. Ogumnyi, (1984) recommended that students should sit on alternative seats (that is, not their usual seats) when taking the examination. This may not be possible in the Kenyan situation but if there is enough room between students coupled with strict supervision, it would hinder students copying from each other and exchanging papers.

One respondent commented that course coverage was important in preventing cheating. Although most of the respondents indicated that they covered all topics in the course

outline, there were those who felt that there should be strict class attendance on the side of both lecturers and students. This would enable those students who are equipped with the necessary abilities, to understand when the lecturer teaches and their motivation for good performance would be heightened.

Another strategy to curb cheating was frequent administering of test and assignments. The respondents who commented on this issue said that there was need to familiarize themselves with examination format and way of answering questions in order for their confidence to be boosted in preparation for the end of term or stage examinations. S14 commented, “Students should be shown how to answer examination questions to minimize examination cheating”; and another respondent said examinations help them to gain more knowledge by applying what they have been taught, for what they practice stays in the mind. It may be concluded that when students understand the course content well cases of cheating would decrease since they would feel confident and prepared to tackle what is expected in the examination.

Effective communication of academic policy and examination regulations is important so that all students are well versed in them before examinations. The study results show that three respondents from one institution did not have an idea of what the academic policy was. Since respondents were chosen randomly, it may be that there are many others who do not know about the academic policy at that institution. Respondents from the other institution had adequate knowledge of the academic policy and the researcher observed that there were less cases of cheating at that particular institution. From this, it may be said that institutions should make sure that new students are oriented to the academic policy and copies of the policy be displayed at strategic positions within the institutions. Strict penalties should be set so that when one is caught cheating is punished; consequently others would fear to repeat the same mistake. No student would like to be disqualified or ordered to repeat a course while his or her colleagues continue to the next level.

Apart from orientation to the academic policy, seven respondents stated that students

need to be counselled in order to enlighten them on the consequences of cheating. Counselling is important since it helps to instill self-discipline in students and self-disciplined students are not easily attracted by bad practices such as cheating. S3 said to prevent cheating, “students need to be counselled on the effects and consequences of cheating”; and another respondent, S5 commented that discipline should be instilled in the students as this may be a process of bringing change in their lives. Counselling that encourage students to work hard to internalize what they learn would go a long way in helping them (students) to discover their potential in their studies. Counselling may also help to instill moral values in students so that they become capable of distinguishing between what is wrong and what is right, as they lead their lives at colleges. If students work hard and pass their examinations without cheating, they will realize they possess the necessary capabilities, and therefore would feel empowered to desist from committing vices such as cheating.

## **7. Conclusion**

Cheating is at its highest levels in our institutions today. Students are taking advantage of technology and lecturers’ reluctance to report cases of cheating. While cheating will likely never be eradicated completely, guidance and counselling may eventually weaken the urge to cheat among students.

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**The Impact of Pre- Service Teacher's Awareness of Bio- entrepreneur Skills, as a  
Panacea for Reducing Unemployment among Biology Graduates in Borno State, Nigeria**

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## **INTRODUCTION**

The roles play by science and technological education in the growth and development of the national economic cannot be over emphasized. Any nation with priority in science and technology education will among other things improve its economic growth substantially hence reduce the impact of the menace due to global economic depression. In their study strategies for combating global economic crisis in Nigeria through science and technology education. Udugo and OJIAKU (2012) cited Abba, (2010), that developed nations like U.S.A, Japan, who acquired their prosperity through science and technology advancements are leading in industrialisation because their scientist passes greater amount of technical know and know practice them than the rest of other nations world.

According to Kumuyi (2010) advised the reactions call for every ones hand to be on the spindle so as to overcome the enosis before us. He maintained for attention should be directed to science and technological education which are the base of any nations development and sustainable.

According to Chaston (2009) Economic recession is define as economic go slow which brings an economy to low ebb and maintained, that it can be explained as a difficult time for the economy of a country. A period when a country experience less trade and industrial activities that often result in high unemployment rate, redundancy, business short down or systematic distress of business venue. Which subsequently generate hardship,, high eve poverty, frustrations unbearable misery that usually push the business into financials slump, income down or collapse or investment. Through scientific knowledge the general public which be given the power which enable them to explore the natural endowment by create resources. Conquerer qualities of life. It is in that light that pamper and humble (2009) describe science and technological education as a process of teaching in school to improves one knowledge about ones environment and to develop ones environment and to develop ones skill of systematic enquiry. But due to economic recession in Nigeria face many challenges such as social, economic environmental which results into unemployment and poverty. It is on this premises that Nigerian government in the recent times compelled to initiate the training of youth in various enterprenual skills which is aimed at making individual being gainfully self employed . Aniamaa and salome(2017) stated that science and technology offer a lot in socio economic and cultural development of any Nation. It is dynamism and the introduction of new technologies has influenced new discoveries and development in biological knowledge.

Therefore sound education is needed for reveal biology skills which are necessary for providing entrepreneurship skills which is aimed at making individual being gainfully self employed (Aniama Salome 2017) science and technology offer a lot in the socio economic and cultural development of any nation. Its dynamism and the introduction of new technologies have influence new discoveries and development in biological knowledge. Therefore sound education is needed to reveal biology skills which are necessary for providing entrepreneurship the great potential biology has a discipline cannot be over emphasized this goes to said that achieving the millennium goals a been giant economic will require among other things indicating in the students of biology at all levels of entrepreneurship skills. This focus is currently is lacking in the Nigerian educational system leading to production of many graduates who are not either gainfully employed or self employed. This is line with Offormas (2005) advice

as she said that for Nigeria to become a key player in the world economy of the 21<sup>st</sup> century, the educational system should provide job creators and job seekers. Togoe(2012) started that education is the process of conveying usable information to group of learners . similarly (UNESCO 2011) quality education is one that satisfy basic learning needs and enriches the level of learners and their overall experience of learning therefore to achieve education, relevant knowledge skills and attitude that are necessary national development must be taught to the student for sustainable development education should be given top priority because it does are open to onto lift them out poverty by through economic growth and national productivity.

#### PROBLEM OF THE STUDY

Biology education is one of the science subject been taught at secondary and tertiary level of education in Nigeria.In these levels be it secondary, tertiary or university. Teachers often concentrate on imparting the incentive development aspect of biology in other words the theoretical aspect has been taught to the students leaving out the educational aspects. This is so because the product of biology, this school will be employed by the government in the pass schools but as a result of global economic aspect where government cannot longer employed which number of students product of this school. This father increase unemployment and poverty for instance in Borno state science inception of the present administration the embargo placed on the employment still on the subsequent graduate in various old of studies. Therefore it is against the background that the study entices to identify biological skills needed to be acquired by the students and the label of their awareness to enable them become gainfully self employed on leaving school.

Aims and objectives of the study are as follows:

1. To examine entrepreneurship opportunism available in biology education to combat economic recession.
2. Determine the level of students/teachers awareness in the bio- entrepreneurship skills opportunities.
3. To determine the students interest in acquiring entrepreneurs skills for business.

## **RESEARCH QUESTIONS**

1. What are the bio entrepreneurship skills available to biology students to aid ameliorate economic recession.
2. What is the level of awareness of biology student's bio entrepreneurship opportunities?
3. What is the extent of biology student interest in acquiring of interpersonal skills for bio entrepreneurship venture?

## **SCOPE OF THE STUDY**

The study on strategy for combating in Nigeria economic recession through the use of biology education entrepreneur skills, In Borno state tertiary institution a case study of some selected tertiary institution BocoBama, Sir Kashim college of Education and Wakabi college of Education.

## **SIGNIFICANCE OF THE STUDY**

The study titled strategies for combating economic recession in Nigeria through the use of biology education entrepreneurship skills in Borno state tertiary institution the findings of the study useful to significance to teacher, students and provosts of college of education. Pre- Service Teachers will benefit by acquiring bio empowerment skills so that they can be self employed. Teacher would benefit from the skills so that they would be sustainable. Government would benefit from the teaching of bio entrepreneur skills because it would reduce funding and provide avenue for reducing unemployment in the Nation.

## **METHODOLOGY**

The study adopted the survey design, the target population of the study comprised of all students offering biology in the 3(three) selected colleges of education. Namely, College of Wakabi, Sir Kashim Ibrahim college of Education Maiduguri; and Umar Ibrahim college of Education, Science and Technology Bama. The population of the

students offering biology from these colleges was 600. The grand population of 600 students across the three selected colleges of education were used as a sample for the study. In each of the selected college, fifty percent of the population was randomly selected. Therefore, a total number of 200 students each from the selected colleges were involved in the study and they were picked from the List of college number of students indicating their year of admission. According to Bor and Gall (1971), that all individual in the define population have an equal and independent chance of being selected as a member of the sample. Data was collected using questionnaire derived from four research questions of the study titled “ Role of Bio enterprenual skills opportunities in Biology education in eliminating the economic crisis in some selected tertiary institutions in Borno state the modify four rating state was used to score the items of the questionnaire. The ratings of the response were strongly agreed (SN)=4, Agree = 3, disagree and strongly disagree = S(DA) the questionnaire has two section, A and B. section A is on personal data of the respondents while section B sought information on the bio enterprenual skills available n biology education in tertiary institutions of Borno state.

The face and content validation was done by expert in science education curriculum. Various corrections and suggestions made were used to modify the instruments.

The test – retest technique was used to gauge the clarity and the relevance of the research instruments. the instrument was tested in the college of education which was not part of the study, and then retested after a period of interval in the same college as pilot study. 50 responses were used as row data to obtain the correction coefficients between the corresponding data pilot for the law time.

The questionnaire was administered, and the instrument yielded a coefficient value.

The 50% of the students in each of the selected college of education (100) were administered with the questionnaires. After the data was obtained, were analysed using descriptive statistics, frequencies and percentages.

## **RESULTS AND DISCUSSION**

Research question one (1) in other to obtain the Bio enterprenual skills available in

Bio Education.

XVIII.	Posses in the depth knowledge of Bio	150
	44	
XIX.	Creative ability	156
	70	

The table above shows that 150 respondents represents 75% says yes of the item one of the question. i.e students of biology must have depth knowledge of Bio while only 25% responds negatively analysis or the table. On leadership and discipline position of 50% of the respondents agreed with the research question while 90 represents 35% percents of the respondents separated disagreed. Similarly or the ability share opinion and communication effectively.

The table 1 above revealed that 75% of the respondents agreed that sharing and communication ability is necessary for bio enterprenual skill acquisition where as 25% of them, reported No on item number(8) that planning and organisation ability is necessary .

The results in table also revealed that 85% of the respondents agreed on the ability to formulates good entrepreneur decision is necessary for acquisition of skills in biology as a course of study aware of the entrepreneur skills area.

Table 2 below shows results for the analysis of research.

Questions 2 states above, the results on students response on the awareness of enterprenuals skills areas in biology Education.

S/N	AREAS	Response	no	Total
1	Micro biology/ parasitology	20.1%	180.9%	100%
2	Medicinal biology	11.55%	189%	
3	Environmental biology/ ecological students	12.5	94%	
4	Bio geography	90.45%	175%	55%
5	Bio chemistry	15.75	110%	

6	Waste managed conversation	178.5%	92.5%	95%
7	Hydro biology	105%	91.5%	
8	Economic botany	105%	190.95%	95%
9	Food technology	157.5%	40%	
10	Biology	189%	185.92%	91%
11	Genetic engineering	105%	190%	90%

The table 2 above reveals that 90% of the respondents reported not aware of micro biology/ paarasitology as entrepreneur skills areas in biology education where only 10% of the students are aware on the medicinal biology for entrepreneurs skills development, the table2 reveals that 94% of the respondents are aware while on 8% reported un aware on environmental biology and ecology areas of vital skills acquisition area in biology the results in the table results shows that 88% of the respondents agreed that they are aware where 12% of the respondents were unaware of the skills. This is certainly to the other findings in the study. The table also reveals that 90% of the respondents were unaware of bio geography skill, for entrepreneurship development while only 10% the respondents reported aware of biochemistry skills in body study for entrepreneur development. 93% of the respondents reported unaware. While only 7% of them agreed awareness on were the management entrepreneur skills potentials, 92% of the respondents reported unawareness while only 8% of them attested awareness. Similarly hydrobiology/ aquatic biology, 95% of the respondents attested unawareness of the entrepreneur skills while only 5% of them reported that they are aware on economic botany. 77% of the respondents reported that they were unaware of availability of entrepreneur skills in the area where as 23% of them, agreed, awareness, similarly on food technology, areas for skill development. 80% of the respondents a great of unawareness while 20% of them shown awareness on Genetic engineering, 88% of the respondents showed unawareness of the knowledge area between entrepreneurship skills, whereas only 12% of them reported awareness.

Student offering Biology as a course of study in the college of education showed the entrepreneurship skills development in the subject areas.

Table 3 below shows the result for analysis of whether students offering biology have interested in acquiring entrepreneurship skills development of some of the areas in the subject.

The results on student response on whether they are interested in acquiring entrepreneurship skills in biology education.

	Yes	Percent	No	Percent	Total %
College A	88	93%.	12	7%	100
College B	90	95%	10	10%	100

The table 3 shows the majority of the students represents 93% reported that they have interest in acquiring the entrepreneur skills available in some of the cities in biology education, only four of them, represents 7% show level of interest. The also revealed that 95% of respondents indicated that they have interest in acquisition of Bio- entrepreneur skills, while, only 5% of the respondents indicated no interest. Therefore biology teacher should encourage student interest through instructional practice as strategy to reduce the problem of unemployment and economic crisis in Borno state, in particular and Nigeria as a whole.

### **DISCUSSION OF FINDINGS**

The study assessed the role of bio entrepreneur skills in some of the areas in biology education in eliminating economic crisis in Borno state; The study raised three research questions.

Therefore the finding of the study based on research question one (1) on table (1) on type of entrepreneur skills available on biology education and whether this skills are necessary for the development of entrepreneurship in students, reveal that most of the respondents agreed for this study. That all the skills listed in table 1 are necessary for the development of entrepreneurial skills in biology students as shown by higher percentage of response to each item of the research question based on skills. This finding is in line with

that of Amama (2017) in a study that biology is a development of Nigeria. Utilisation of biological science education for empowerment. A global challenge records that biology is a powerful tool for economic, social, and political development of Nigeria. Hence there is need to build into the biology curriculum

Bio entrepreneur skills necessary for bio entrepreneurship ventures.

From the above findings, evident that make biology teaching cash product will help alleviate the problem of economic crisis.

The second findings revealed that the majority of the respondents attested that they have interest in acquiring bio enterpreneural skills. This may not be unconnected with the fact because of economic recession, government at both state and federal and no longer employ our teaching graduates from educational system. Hence any skills that will enable students to be self employed focus their attention, graduate, self employment will no doubt reduce the burden of the economy of Nigeria. These findings collaborate with the findings of Anyanwu (2010), in study embowering youths for sustainable development. Ascension of entrepreneurship skills need of youths who view entrepreneurship as the ability to be creative utilising opportunities available for both self sustenance and contributing to the needs of other.

This finding is also in line with the findings of Amama(2017) who sees enterpreneural skills acquisition as an improvement in both the labour and the business sector, since it is very important to develop positive interest in whatever field of endeavour one want to engage.

The third findings indicate that95% of the respondents reported unawareness of the entrepreneurship areas in biology education; the awareness level was recorded low in the stud. The implication is that if students were unaware of the areas in biology where students can create job for himself, the level of poverty will increase. Therefore teachers of biology will blend the contents and the instructional practising as a powerful strategy for eliminating current economic crisis.

## **CONCLUSIONS**

Based on the findings of the study, it was concluded that economic crisis in Borno state in particular and, Nigeria at large left all sectors in doom, especially the educational system

where thousands of graduates were unemployed which may subsequently create other societal problems to this end. So therefore if the strategy of Bio entrepreneurship skills in biology education area are incorporated into biology curriculum and taught along side with the cognitive aspect of the subject, it will no doubt boost production and accelerate economic development of Borno state, tertiary institutions provide a platform where many unemployed graduates of biology become self-employed, thereby reducing the effect of the economic shrinkage in the country.

### **RECOMMENDATION**

Based on the findings of the study, the following recommendations were made:

- Biology teachers at all levels should make teaching of biology cash productive.
- Acquisition of bio entrepreneurial skills should be made compulsory and part of the curriculum.
- Government at all levels should assist financial educational institutions for the purpose of training the students, the bio entrepreneurship area in raising the subject of the study.
- Government should encourage the students acquiring the bio entrepreneurship skills will take up development fund to enable them to set up their own business for self-reliance.

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# **Effects of Hypermedia on Learning Achievement in Geography for Hearing Impaired Learners in mixed Special Secondary Schools in Kenya**

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## **ABSTRACT**

The hearing impaired (HI) students often encounter communication problems in classroom. Yet some specific media can facilitate and enhance their learning. This study reports on the development of hypermedia educational instruction that supports HI student's achievement in Geomorphology. The objectives were; find out the achievement of students exposed to hypermedia lesson in Geomorphology, gender disparity, determined changes on the role of both students and teacher. The study was informed by multiple intelligence and cognitive theory of multimedia learning regarding individual differences and strength of the brain to store well and recall images as opposed to text. The study assumed a pragmatic research paradigm adopting mixed methods using quasi experimental approach involving Solomon four nonequivalent control group design. Simple random sampling procedure was used to obtain four schools, two for experiment and two for control group. Data collection instruments were pre-test, post-test and questionnaire. Data were analyzed using descriptive and inferential statistics. The results revealed that use of hypermedia for teaching HI resulted in higher achievement, girls improved more than boys, there are changes in role; students from passive to active, teachers from dispenser of knowledge to facilitator. Hypermedia allows interaction and self-learning. These findings may create awareness and need for integrating hypermedia in pedagogy for improved performance, thus helping learners to focus attention that promotes teachers' instructional technique. The following recommendations were made; review of curriculum and digitize HI content, improve ICT infrastructure and facilities.

**Key words:**Hypermedia, Geomorphology, Hearing Impaired, Achievement

## **Background**

The world is moving very fast into a digital multiple periods in an environment characterized by ICT with its tenets that can improve achievement and change roles in teaching and learning process. Disability has largely been invisible in the instructional implementation, and is rarely included in national policies and programmes, This has perpetuated a situation in which environmental barriers are still preventing persons with disabilities from accessing, participating and being fully-included in education activities. Hearing impairments (HI) present challenges to quality education both pedagogically and logistically. Many of the learning strategies used by teachers tend to be audio based. Many HI learners across Kenya cannot benefit fully from a traditional instruction because of hearing impairment which limits their ability to actively participate in classroom learning activities. Sign is a visually-based, not auditory, code with a grammar different from that of written for example “processing land instead of land processing”. Deaf students often miss out on secondary learning opportunities that are afforded to hearing peers (Parton, 2006). Fgatabu (2013) found that sign language has a great effect of performance on learners with hearing impairment. One of the main goals of Education in Kenya is a right to provide equal educational opportunities to every child, irrespective of their real or imagined disabilities, (EFA, 2004). Inclusive ICTs can enable persons with disabilities as agents and beneficiaries to fully access education, skills training, employment opportunities and among others. When information is available in various forms (alternative formats), it reaches everyone who may be interested. Hypermedia also caters to various learning styles and individual learning needs by providing information in a multitude of media formats.

Traxler (2010) asserts that about 50% of a national sample of students with HI at high school produced results that were below basic proficiency level. Bashir et al. (2014) denotes that in a research on the academic achievement of students with HI show that they trail behind their hearing age mates at the same age and grades as regards what is expected of them. Adoyo (2004) affirms that deaf students in Kenya have consistently trailed behind their hearing counterparts in academic performance. As essential factor for effective technology integration is the teacher, since she/he directly indicates the best instructional practices for his/her students (Rehmat, 2014). The teacher should become

one of many resources that the student may learn from, engage students in experiences that challenge previous conception of their existing knowledge, allow students responses to drive lesson and seek elaboration. Success hypermedia integration is what makes a difference in reforming a classroom. Therefore Adesina (2009) and Obanyan (2010) come to a conclusion that teachers are the key pointers and determinant of a successive education. They make practical choices of tools and media that will shape the way students learn, express themselves and perform (Drayton, Falk, Hobbs, Hammerman, & Stroud, 2010). Northern Environmental Education Development (2011) presents new opportunities to develop resources such as hypermedia to shape teaching and learning. Debates still exist as to the pedagogical value of many hypermedia applications and, despite multiple experiments, researchers have failed to resolve many of the basic issues concerning the use of this technology for instruction. The objectives were; find out the achievement of students exposed to hypermedia lesson in Geomorphology and gender disparity.

### **Problem**

There is increasing concern with poor academic performance in Kenyan schools for the deaf. Kiboss (2012) found that Kenyan high school student with hearing impairment scored lower in math tasks. Adoyo (2014) indicates that poor performance is attributed to inappropriate teaching methods, like in traditional classroom settings where the teacher will begin class by answering questions from the previous work, then teach the new lesson, give notes and sometimes give assignments. On the other hand special schools are segregated and discriminated against yet classroom achievement is low (Mulambula et al, 2012). Studies reveal lack of instructional materials yet effective teaching contributes to 75% of good academic achievement. It is also evidenced that teachers' use of 85% adapted technology and 25% adapted ICT in pedagogy cannot be realized in a dilapidated instructional environment (EU Report, 2012). Other studies consider KSL as a medium of instruction may also contribute to poor performance because exams are set in English, switching between KSL to English may cause misunderstanding (Adoyo, 2001, 2004, Ogada, 2012). Based on the constraints of the typical HI student, the teaching strategies and material used in curriculum for HI student cannot effectively teach the required geographic skills. The previous research shows that hypermedia instruction embodies all

instructional forms that accommodate the needs and disabilities of different hearing impaired learners (Andrei et al., 2013), therefore can alleviate this issue in physical Geography. Chickering&Gawson (2011) emphasized that active classroom involvement is not just sitting and listening to the teacher sign but by talking about what they learn, write about it, relate it to past experience and apply it to their daily lives. Teachers need to use alternative media with individual work so that the deaf student does not need to concentrate for long time. To rectify this, teachers need to integrate appropriate image-based and iterative strategies necessary for effective instruction of these students (Lang &Pagliaro, 2007).

### **Theory**

Technology has changed the way we teach and learn. Many learning theories can be used to apply and integrate this technology more effectively. Shatila (2015), humans are their own agents of change because they are in charge of choosing their action. Hypermedia leads to a cognitive pattern of engagement and motivation of instructional tools, which individualizes the mode of delivery, developing special teacher, fortifying the teaching process and encouraging students to stay on task (Kazan, 2015). But hypermedia allows the teacher to expand his/her methods, tools and strategies beyond that are frequently used in the classrooms. The most important features in the development of hypermedia for HI are video, animation, text and graphics. In relation to this theory, visual cue is the most important element in developing the hypermedia for the HI learners (Faizah&Ariffin, 2010). MI theory has the capacity to solve problems encountered by HI learners as they have different disabilities for example in a class a teacher may be having deaf, loss of hearing, deaf and hard of hearing these may have different degree of profoundness. But hypermedia gives opportunity to choose which way to go.

### **Methodology**

The study assumed a pragmatic research paradigm as data was collected systematically using quasi experimental approach. It adopted a mixed method (MM) of inquiry in a transformative procedure (Creswell, 2013). The study used quasi experimental design involving Solomons' four non-equivalent control group design. It was conducted in Kenya in East Africa. The target population were twenty hearing impaired mixed special

secondary schools in Kenya. There are twenty principals, forty Geography teachers, 835 students and NGOs. The four schools were randomly a signed to experimental and control groups. A total of 79 students and 10 teachers were sampled. The instruments such as questionnaire and Geography achievement test (GAT) were used to collect data. Validity were ascertained by the experts and reliability conducted in two schools through test-retest method. Descriptive analysis was used to summarize data, which was presented in tables. Inferential statistic involving chi-square and t-test for testing hypothesis were employed.

## **The Findings and Discussion**

### **1. Integration of Hypermedia and Students Academic Achievement**

The experimental group was exposed to hypermedia and control taught by regular method of teaching (RMT). The finding recoded high mean scores gain (47.07%, 42.13%) by the experimental group who achieved statistically significantly higher scores in the GAT than control group as revealed in table 1. This is in line with Parton (2006) who identified five ways that hypermedia application can promote achievement and learning for students who are deaf. These include; improving accessibility, instructional design, promoting development and creating discovery learning. All these put together leads to higher scores than those taught without use of hypermedia.

**Table 1: GAT Pre-test, Post-test Means and Standard Deviation**

<b>Variables</b>		<b>Pre-test</b>		<b>Post-test</b>	
<b>Method</b>	<b>N</b>	<b>Mean</b>	<b>Sd</b>	<b>Mean</b>	<b>Sd</b>
Conventional C <sub>1</sub>	15	48.07	9.1	47.07	8.6
Conventional C <sub>2</sub>	23	—	—	42.13	8.7
Use of hypermedia E <sub>1</sub>	21	43.62	8.0	54.71	8.5
Use of hypermedia E <sub>2</sub>	20	—	—	53.2	9.3

N= 79

To establish whether there is any significant difference in achievement between students exposed to hypermedia and those taught through conventional method. The achievement of the students on concept is attributed to several factors. To minimize on the effect of intervening variable, it was important to establish behavior of two groups and compare

the results with the group whose entry behavior were not established. Pre-test was administered to two groups, one from control and the other from experimental. Before the use of any media, the entry behavior must be established. Pretest itself is an intervening variable because it prepares the subjects for what is expected at the end of the exercise. However pre-test did not have significant. As shown in table 1, there is no evidence on the means that the subjects had prior knowledge. Pre- test had a mean of 48.07 and posttest 47.07, and experimental pre-test mean was 43.63 and posttest 54.71. The increase in mean was probably due to treatment for one month. Hypermedia is an instructional media capable of improving achievement especially for the HI learners who are visual learners. It allows the students to engage more fully with the subject matter at hand and facilitates deep understanding. The finding concurs with Schmidt et al. (2009) who affirm that hypermedia has ability to develop important understanding and reasoning skills such as critical thinking, problem solving and prioritization.

## 2. Pre-test Data Analysis

Table 2 reveals that Geography means score of experimental and control groups on pre-test GAT means scores were analyzed using t-test for independent samples analysis. The results indicates that control had (M=48.07; SD=8.6) and experimental registered (M= 43.6; SD= 8.0). These scores are relatively low, this could be attributed to the fact the topics are abstract and terminologies are difficult to explain effectively in KSL. Several scholars postulate that poor performance has been attributed to poor teaching strategies and medium of instruction for the HI learners (Adoyo, 2001, 2004; Ogada, 2012). Dye et al. (2008) affirm that there is also shortage of qualified teachers of deaf and of research-based teaching methods and instructional materials for HI.

**Table 2: Pre-test Data Analysis**

<b>Group</b>	<b>Mean</b>	<b>Standard deviation</b>
Control	48.07	8.6
Experimental	43.6	8.0

Data in table 3 indicates variability in the mean obtained by different groups. The difference in means may or may have not been caused by chance. To ascertain, an independent sample t-test was carried out at a significant level of  $0.05\alpha$ . The following

were the results of inferential statistics.

**Table 3: t-test of Pre-test Means between Experimental and Control Group**

Variable	Df	Sig. ( 2 tailed)	Mean difference	Std err difference	95% interval of the diff	
					Lower	Upper
Pre-test	34	0.130	4.45	2.86	-1.372	10.268

The study carried out the t-test on the means of experimental and control to find out whether the means are significantly different. since the data did not provide sufficient evidence for rejection. It was therefore concluded that there is no significant difference between students in these schools. Meaning the entry behavior of the groups is similar and therefore giving the two samples (C & E group) homogeneity status. During form one selection, students are selected randomly so long as the student has attained 150 marks and above which is the KCPE pass mark for the HI students. All the HI secondary schools are national schools hence the entry behavior is the same. Disparity in achievement heavily relies on other factors such as environment, facilities, administration and pedagogy. The finding is in line with Means (2010); Shapely et al. (2010), when students are engaged in technology-immersed classrooms, there is a gain in achievement in all subject areas.

**Table 4a: Pre-test between Control Boys and Girls**

Gender	N	Mean	Sd	df	t-value	p-value
Male	12	46.58	9.6	34	0.73	0.942
Female	3	54	2.65			

P > 0.05, Not Significant

On comparing the means of control boys and girls, the statistic output in table 4a reveals that means score of girls (M = 54; SD = 2.65) and boys (M = 46.58; SD = 9.6);  $t(34) = 0.73$ ,  $p > 0.05$ . The p-value of 0.942 is greater than the testing point of 0.05. This indicates that the pre-test means of the boys is not significantly different from pre-test means of the girls. It is evidenced that the mean achievement of the control group due to gender was not significantly different at 0.05 levels. The null hypothesis was accepted since the data

did not provide enough evidence for rejection. Hence it was concluded that there is no significant difference between pre-test achievement of girls and boys students who were taught through conventional method of teaching. Meaning the entry behavior of the groups may be similar for having same means. Girls are competent just like boys and disparity in performance is affected by other factors. The finding is supported by Abubakar&Oguguo (2011) in their comparison, found no significant difference between performance of girls and boys. This agrees with Uduosoro (2011) who found no significant difference between performance of boys and girls. DFE (2007, p. 3) affirms that factors such as ethnicity and social class have a greater bearing on educational achievement than gender considered on its own. But a high standard deviation of 9.6 by boys clearly show that they achieved more than girls in terms of average as shown in table 4.7b thus they had better grades Agbuga& Xiang (2008) report that boys recorded high performance than girls in Geography. The result is similar to that of Kubiatio et al. (2012), the influence of gender was significant and the boys achieved statistically significant high scores.

**Table 4b: Pre-test between Experimental Boys and Girls**

<b>Gender</b>	<b>N</b>	<b>Mean</b>	<b>Sd</b>	<b>Df</b>	<b>t-test</b>	<b>p-value</b>
Male	14	44.64	7.4	35	4.4	0.000
Female	7	41.57	9.3			

P < 0.05, Significant

Table 4b reveals that significant difference exists between pre-test means score of girls (M= 41.57; SD= 9.3) and boys (M= 44.64; SD =7.4); t (35) =4.4, p< 0.05. The p-value 0.000 is less than the testing point of 0.05 $\alpha$ . Therefore the result indicates that difference exists between experimental girls and boys. Boys before instruction are more competent than girls in Geography achievement. This could be attributed to perceived differences in the learning styles of boys and girls. This is one of the most frequently expressed explanations for the gender difference in achievement. Boys learn by doing things such as experiments or activities and girls would learn well visually by seeing. The finding is supported by Husain & Millet (2009), who report that test scores differs substantially by

gender, significantly more boys than girls score very high ranges in Geography thus gender disparity is significant. However this result is contradicted by Zember&Blume (2011) who report that most studies show that girls perform better than boys in schools. Warrinto&Younger (2007) reaffirm this reporting that girls outperform boys.

#### 4. Posttest Analysis of Data

After a period of four weeks of learning Geomorphology, a posttest was administered to all the groups. This time the means were relatively high as compared to pretest. Experimental had a mean of 53 and control 47.1 as table 5 indicates. This could be attributed to the teaching instruction that had been used. Research has demonstrated that different teaching methods produce different results therefore the identification of the best teaching strategy must be done if the best results must be achieved (Houston &Parigoe, 2010). The outcome from previous research indicated that teaching with learning style adaptation increased students' performance and boosts their motivation to learn (Avile&Moren, 2010).

**Table 5: Posttest Means at Group Level**

<b>Group</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>
Experimental	38	53	9
Control	41	47.1	8.5

It is evidenced from table 5 that students who were taught by use of hypermedia achieved statistical significantly higher scores in the GAT compared to those taught through regular teaching method. Table 5 reveals the results of different groups that sat for the posttest. Experimental group had a mean of 53 and control 47.1. This descriptive analysis shows a probability of experimental group being superior in achievement. However this can only be confirmed by an inferential statistic that will be carried out at a later stage.

**Table 6: Posttest Means and Standard Deviation at School Level**

<b>School</b>	<b>Posttest</b>	<b>SD</b>
Experimental (pre-test)	54.71	8.5

Experimental	53.20	9.3
Control (pre-test)	47.07	8.6
Control	47.13	8.7

The results as per schools are shown in the table 6 as follows; experimental pre-test had a mean of 54.71, experimental posttest only recorded a mean of 53.20. The difference in achievement of the two groups should be explained as influence of pre-testing. Pre-test may have influenced achievements. In control group, control pre-test had a mean of 47.07 and control posttest only recorded a mean of 47.13. This is contrary to experimental groups. The group that was not pre-tested is above the group that was exposed to both tests. This shows that pre-test did not have influence on posttest. It can be hypothesized that experimental are competent than control. The competence of experimental is attributed to hypermedia treatment they received. However this is subject to confirmation after inferential statistic is carried out on the data as illustrated in table 7.

**Table 7: t-test of Posttest and Pretest Difference**

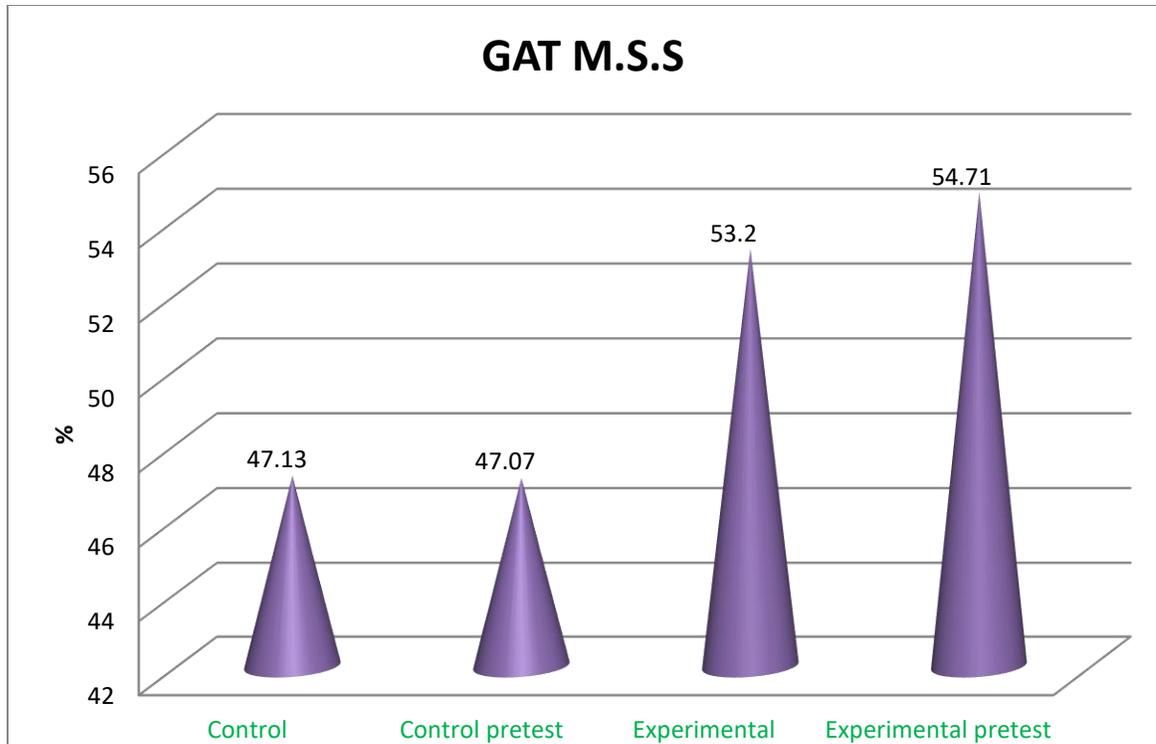
Variables	Df	Sig. (2 tailed)	Mean difference	Std err difference	95% confidence interval difference	
					Lower	Upper
Pre-test / posttest	35	0.000	6.056	1.377	3.261	8.850

An independent sample t-test was carried out for the purpose of inferring from the data and testing of the hypothesis, pre-test had no influence in the study as table 7 reveals. The t-test p- value was 0.000 as table 7 indicates. The t-test p-value is lower as compared to the set alpha of 0.05. This shows that there is statistically significant difference in the pre-test and posttest. The findings that high achievement was recorded on the posttest GAT could be due to some groups being given treatment. Mayer (2005) asserts that hypermedia is more effective for learners with low aptitude and it helps them to connect the new knowledge with the prior knowledge. Further finding indicates that support with careful planning, experience in teaching in a virtual environment can promote achievement in learning (ICM, 2012).

**Table 8: t-test of Posttest Means between Control and Experimental Groups**

Variables	df	Sig. (2 tailed)	Mean Difference	Std err Difference	95% confidence interval difference	
					Lower	Upper
Posttest	77	0.001	6.870	1.952	10.157	2.983

The study sought to test difference in means of control and experimental group. The significance was to establish the effectiveness of hypermedia as opposed to conventional methods of teaching. The t-test p-value is 0.001 less than alpha 0.05. This reveals that there is a statistically significant difference in the posttest means of experimental group and control group. The difference is in favour of experimental group that was exposed to hypermedia. The finding that the mean of experimental is high leads to conclusion that hypermedia is effective in improving achievement in learning Geomorphology in Geography by HI learners. This is because hypermedia enhances ranges of sensory stimuli in instructional circle, hearing, seeing and doing play important role in achievement. Moreover opportunities to learn from classmates are often lessened due to communication. Several research have supported this finding for example the findings of earlier studies, deaf students often perceive that they receive a distorted message when a non-signing teacher's lecture is translated by the interpreter (Vignare et al., 2007). Nearly 40 hypermedia studies found that compared to traditional lecture, learning improvement were higher for the groups that used hypermedia. This was further supported by meta-analysis by various researchers who examined over 200 studies that compared learning presented in traditional way to the same information presented via hypermedia instruction and found that learning was higher through hypermedia than traditional (Long et al., 2011).



**Figure 1: GAT Means by Groups**

Control underperformed because HI students have difficulties in visualizing the concept of landform processing. These learners are lip readers hence require intense concentration and this is tiring over long time, this could have led to poor performance. Adoyo (2004) indicated that poor performance of HI is attributed to inappropriate teaching techniques. Teachers are not presenting the curriculum material in a logical form that is accessible to deaf students. They struggle to provide them instruction after class learning support (Liu & Hong, 2007). Zhang & Zhou (2006) further assert, the traditional mode of teaching is sign method, which has been criticized for being tiring, boring, authoritative and emphasis on memorization. Slobodzian (2009) affirms that extra learning resources may not be accessible in class and there is a widespread lack of accessible interactive materials (Parton, 2006).

**Table 9: t-test Posttest Means between Experimental Girls and Boys**

Variables	Df	Sig. (2 tailed)	Mean Difference	Std err Difference	95% confidence interval difference	
					Lower	Upper

Posttest	77	0.756	0.712	2.284	-3.836	5.259
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Table 9 reveals that no significant difference exists between posttest Geography means score of girls and boys. An independence sample t-test for the group gave a p-value of 0.756. The p-value is greater than the set alpha 0.05. This means that there is no difference in the posttest in Geomorphology using hypermedia technique due to gender. The null hypothesis is therefore retained since the data did not produce sufficient evidence for rejection. This result implies that gender does not have any significant effect on performance means score of students exposed to hypermedia technique. Thus students perform independent of gender when taught using hypermedia. It also suggests that teachers should integrate hypermedia to teach students in order to reduce any gender difference in students' achievement in Geography. The finding of gender difference is in line with that of (Esiobu, 2011), gender is no longer a significant impediment for performance. However Zamfirov&Saera (2013) contradict, they found that girls and boys learn differently by considering difference in achievement. Further, in teaching Geography, Gender Geography (2010) research suggests that a strong masculine bias exists in the map reading. However Guis et al. (2008) had different opinion in their finding, they found that there is gaps in test score in all subjects.

Before a conclusion was drawn that hypermedia is a treatment that has enabled girls to be as competent as boys, it is necessary to test if the girls in control have performed as well as boys. The study tested the significance in mean difference between control girls and control boys using an independent sample t-test.

**Table 10: t-test Posttest Means between Control Girls and Control Boys**

Variables	Df	Sig. (2tailed)	Mean Difference	Std err Difference	95% confidence interval difference	
					Lower	Upper
Posttest	77	0.002	0.521	0.130	0.289	0.452

The t-test value was 0.002 as indicated in Table 10. The p-value is less than the alpha which was set at  $0.05\alpha$ . On the analysis it is found that the difference in means of control

boys and control girls is statistically in favour of boys. Boys in control have outperformed the girls. This just confirms that it is hypermedia that created conducive environment that led to girls in experimental group to perform as well as boys. Warning, 2006; Younger (2007) affirm that in northern Nigeria, it is believed that subjects like physics, drawing, Geography and the like are for boys and not for girls. This finding is supported by Abigail (2007) assert that there are biological differences in brain development this determines the difference in thinking process between boys and girls. Therefore adapted hypermedia is an alternative to traditional approach to HI learners. It adopts information towards individual preference and improves the experience of the learner who interacts directly with the system. However Warrinto&Younger (2007) contradict the previous finding report that girls outperform boys at school at least in terms of certain key academic hence there is need to refocus equal opportunities to redress the balance for boys. Therefore Alias (2010) reaffirms that it is important to identify the most effective strategies in the content delivery process to achieve objectives.

### **3. Role of the Students During Hypermedia Presentation**

Teachers were asked to state the role of the students during hypermedia presentation. The finding in table 11 indicates that 70% of the students were active. Hypermedia is an interactive learning media. New technology has drastically changed students' role from traditional instruction to virtual learning. Hypermedia is shifting the emphasis from teaching to learning. An active student will have more responsibilities of their own learning as they can share their knowledge with others.

Employing active learning strategies serves two fold purpose; they make a dynamic classroom ever changing environment in which students have a voice and allowed them to view teachers as people who are flexible enough to take risks in the classroom instruction. It also encouraged students to stay interested and learn more from class when teachers used many medium in single application. Hypermedia provides powerful tools to support the shift from teacher centered to learner centered paradigm and new roles of teacher-learner and new media. It is believe that the most important characteristic of hypermedia is its ability to encourage students to be proactive learners (Drayton et al., 2010).

### **Changes in Learners**

**From**

Passive learner  
 Reproducer of knowledge  
 Solitary learner  
 Solely learning content

**To**

Active learner  
 Producer of knowledge  
 Collaborative learner  
 learning to learn, think, create and communicate

However 30% teachers agreed that learning with hypermedia is a passive way of learning. As stated earlier in literature, hypermedia is in three categories that is linear, network organization and hierarchical organization. These teachers could have used linear model which is a passive way of presenting information. In this model both the learners and teachers have very little to do. It is also likely that there are some teachers who have not had experience with hypermedia therefore they are not sure whether hypermedia can encourage passive or active learning. Sivapalan&Crega (2005) concurs that the main challenge is how to enhance students' participation during presentation. Classroom experience has demonstrated that students who contribute to Geography discussion tend to succeed academically, thus there is relationship between classroom participation and student achievement.

**Extent to which Hypermedia Change Teaching Method**

Table 11 reveals that 50% of teachers agreed that use of hypermedia greatly changes their teaching method. Hypermedia application involves use of several medium at ago. This relieves the teacher from carrying into class more medium. Hypermedia has potential to transform achievement of the HI through instructional technique.

**Changes in Learners****From**

Single sense stimulation  
 Single media application  
 Delivery of information  
 Monologue communication  
 Analogue resource

**To**

Multi-sensory stimulation  
 Multimedia application  
 Exchange of information  
 Dialogue & collaboration  
 Digital resource

All these changes in pedagogy demand a new learning environment to effectively harness the power of hypermedia (Zhu, 2003; Kim & Gilman, 2008).

**Table 11: Teachers' Opinion on Application of Hypermedia**

<b>Opinions</b>		<b>Frequency</b>	<b>Percent</b>
Most effective technique Employed	Illustration	3	30
	Hypermedia	2	20
	Power point	5	50
<b>TOTAL</b>		<b>10</b>	<b>100</b>
Role of students during Presentation	Passive	3	30
	Active	7	70
<b>TOTAL</b>		<b>10</b>	<b>100</b>
Extent to which hypermedia Change teaching method	Not at all	2	20
	Much	5	50
	Very much	3	30
<b>TOTAL</b>		<b>10</b>	<b>100</b>

From table 13 it reveals that use of hypermedia leads with 70% teachers accepting that hypermedia achieves equitable learning outcome. This is because hypermedia offers multiple learning styles and therefore each learner could meet his/her learning preference through the use of multimedia which employs the four senses. Students would benefit from the way in which the textbook contents are demonstrated. The use of technology in learning has helped them largely. This motivates their self- learning abilities by pursuing audio-video supported illustrations, texts, graphics and drawings. Chowdhuri et al. (2012) agree that deaf students cannot be exempted from e-learning approach.

None of the teachers agreed that CDROM and hyper-studio can achieve a positive outcome. CDROM is non-visual media thus audio aid therefore many learners are not able to benefit from the lessons in which it is used because majority of the learners in this

study have conductive deafness. Berndsen&Luckner (2010) state that use of CD-ROM in the classroom is still pedestrian. Teachers were not familiar with variety of teaching strategies that can be used with CD-ROMs in order to increase its effectiveness. This is most likely a consequence of lack of available resources.

However CD-ROMs help to standardize the sign for particular concepts. This helps in avoiding to use interpreters who may lack sign for technical terms. This is one of the problems in teaching Geomorphology. Cooshna&Teelock (2006) report that the problem with teaching and learning Geography are terminology, symbols and interpretation of language. In this way technology has become a way of extending and developing good practice and providing permanent visual record. None use of hyper-studio was also noticed, this is a rare technique used in teaching the HI. Hence it is one of the most appropriate media because it can pull a variety of resources together, for example the teacher can have scrolling text for subtitles and video clips for signing, together with still pictures, text and sound. It seems teachers have no idea for this technology and that is why it was not regarded as one of the medium which can provide a positive outcome.

From the results in table 12, most of teachers (80%) agreed that hypermedia can extend learning. Students are able to self-adjust the time and determine the information based on preference since hypermedia provides different alternatives that individual learner can benefit from. Students can use hypermedia on their own time, place and speed to learn the concepts. Ma, O'Toole & Keppel (2008) support the finding reporting that based on individual differences students self-adjust the time and determine alternatives in learning. However few (30%) teachers agreed that hypermedia cannot extend students' learning. This could be attributed to teachers who did not have experience with hypermedia. Hypermedia is one of the recent technologies which have just been introduced in the classroom instruction. These teachers find it difficult to incorporate hypermedia hence believe it cannot extend learning. The finding is supported by several researchers. Mishra & Sharma, 2004; Mantin&Kleion (2008) who assert that, it is challenging to produce and incorporate multimedia enable learning methods into existing practice without creating unnecessary frustration in the learning process.

**Table 12: Media which Achieves Positive Outcome**

Variables	Frequency	Percent (%)
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Achieves equitable learning outcome	Hypermedia	7	70
	CD-ROM	0	0
	Sign it	3	30
	Hyper- studio	0	0
<b>TOTAL</b>		<b>10</b>	<b>100</b>
Hypermedia extends learning	Yes	7	70
	No	3	30
<b>TOTAL</b>		<b>10</b>	<b>100</b>
N = 10			

A further inquiry by an open-ended question was made by asking the reason why the media could extend students learning. Those who said that hypermedia can extend learning beyond classroom gave the following reasons; *TE<sup>1</sup>*, *it improves understanding because students could see the process of various landforms for example formation of headlands and bays*, *TE<sup>2</sup>*, *it can be used anytime anywhere and facilitates creativity*.

The results further revealed that hypermedia is the best because students can access information on their own through navigation. This motivates them hence learn better therefore teachers should always keep learning at the center of learners. Technology is the central focus and heart of all activities and pedagogy in classroom instruction. National Teacher Institute (2006) concludes that I hear I forget, I see I remember, I do I understand.

#### Conclusions

#### Recommendations

National laws and policies should integrate accessible information, communication and technologies to ensure that their implementation enables persons with disabilities access them.

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# **The Impact of Parent and Community Support on Primary Schools' Pupils Academic Achievement in Siaya and Kisumu Counties, Kenya**

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## **ABSTRACT**

The performance of primary school pupils in the Kenya Certificate of Primary Education (KCPE) examinations in Siaya and Kisumu Counties has been unsatisfactory over the years. Most of the candidates obtain at least average and below average scores in the annual examination. This has been a cause for worry among parents, teachers and the community. The purpose of the study was to investigate teachers' perceptions of the influence of parents and community factors on primary school pupils' academic achievement in Siaya and Kisumu counties. The objective of the study was to: establish teachers' perceptions on whether the parent and community support determine primary schools pupils' academic achievement. The study was guided by the Transaction Theory of Teaching/Learning and General Systems Theory. The study was conducted in the counties of Siaya and Kisumu. The study employed the mixed methods approach and was conducted using descriptive explanatory survey design. The instruments used to collect data included questionnaires and interview guide. The sample was selected using stratified random sampling. Data was collected from 136 schools where 136 head teachers and 493 teachers were respondents. The researcher interviewed 36 teachers. The unit of analysis was primary school teachers. Descriptive statistics, such as measures of central tendency, counts and percentages were used to analyze the data. The study found that parenting style, social gatherings such as discos and pupils' absenteeism influenced academic achievement. It was found that since the school is a system, it has sub-systems such as parent community. These sub-systems interacted and were dependent on each other. As such, problems in one variable affected the other. For example, the post-election violence of 2008 which took place in some parts of the study area affected pupils' KCPE achievement.

**Keywords:** Parents, community support, academic achievement, KCPE, Political violence, elections.

## **INTRODUCTION**

The Kenya Certificate of Primary Education (KCPE) examination was introduced in

Kenya in 1985. In the almost three decades which this examination has been done in Kenya, poor academic achievement in schools has been observed all over the country. The cycle of poor achievement in KCPE has recurred every year when the results are released by Kenya National Examinations Council (KNEC). The poor performance by pupils has led to frustrations among teachers, parents and community, because KCPE is a placement examination for secondary schools in Kenya (Adrienne, Lucas & Mbiti, 2012).

Uys (2011) has investigated the factors that influence the achievement of Grade Nine learners and found that school-related factors are to blame for poor performance. According to Uys schools located in urban centres register poor performance because pupils are faced with many challenges such as lack of motivation to learn which affects their achievement.

Reche, Bundi, Riungu and Mbugua (2012) argue that poor performance by primary school pupils in the Kenya Certificate of Primary Education can be attributed to inadequate number of teachers, inadequate learning resources, high teacher turnover rates, inadequate preparation, lack of teacher motivation, large workload and absenteeism by teachers and pupils.

Several researchers in Africa have linked poor performance in primary schools in public examinations to home influence (Makewa, Role & Otewa, 2012; Muola, 2010; Ongeti, 2008; Oluka & Okurut, 2008; Nannyonyo, 2007). These researchers argue that teacher-related factors are a determinant of performance in primary schools.

Eliot and Dweck (2005) have examined how the school environment can affect achievement of pupils. Their aim was to explain the ways in which the school environment influences pupils' achievement in primary schools. They established that the environment of the school had a profound impact on learning.

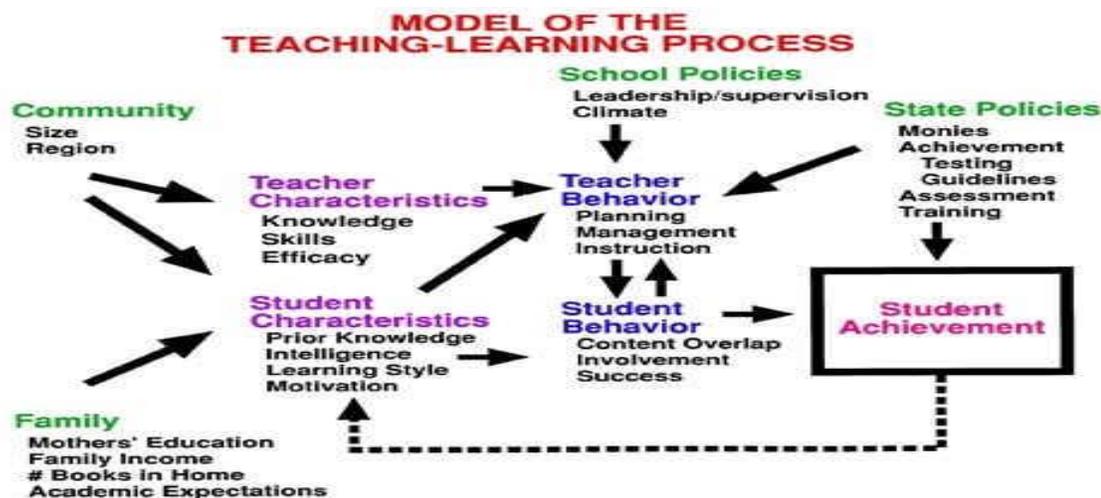
Rivers (2008) posits that socialisation of learners with their families can also affect their

achievement. Learners who come from authoritative homes tend to engage in learning on their own and they do experience intrinsic motivation; pupils who come from permissive homes often lack self-reliance and are therefore academically handicapped. Those who come from authoritarian families are always not independent and depend on their teachers for help and may not do much on their own.

According to information from the Ministry of Education, Science and Technology (MOEST, 2014) pupils from Nyanza region have consistently performed poorly in Kenya Certificate of Primary Examinations (KCPE) results shows that in 2010-2012, 70% to 80% of candidates who sat for KCPE scored below 249 marks out of a maximum score of 500 marks. There is need to find out how parents and community could urgently resolve the problem to enable pupils to acquire quality primary education in Kenya (Omolo, 2010).

A number of studies have been undertaken in an attempt to explain the factors affecting academic achievement of primary school pupils in Kenya (Katana, 2007; Makewa *et al.*, 2012; Aroni, & Ibrahim, 2008). Majority of these studies have focused on exploring the influence of teachers on primary school pupils' academic achievement. Conspicuously absent is a study on the influence of parent community on pupils' academic achievement especially in Siaya and Kisumu counties. Hence there was urgent need to carry out this study.

According to the Transaction Theory of Teaching and Learning, the (output) is the measure of what the pupil has learnt, and it should be done outside regular classroom processes. According to the theory, factors which influence output include: teacher characteristics, learners' and teachers' behaviour, and community and state policies (Huitt, 1994).



**Figure 1.1: The Transactional Theory of Teaching and Learning**

*Source: Huitt, 1994*

The study was also guided by General System Theory by Ludwig Van Bertalanffy (1971). Bertalanffy (ibid.) formulated the theory so as to account for similarities of the functioning of phenomenon in organizations such as educational entities (e.g. schools and other natural phenomena). Bertalanffy (1971) asserts that there are two types of systems; open and closed. In an open system there is a continual input and output of both energy and matter, according to Chandan (1997). The principles of this theory are as indicated below:

- Each system has a sub-system.
- Each system is part of the super-system.
- The inputs, the processes and the outputs within a given organization form stages in the systems cycle of activities/events.
- There is dependence by the organization on its environment.
- There is feedback within the organization.
- There is interaction between sub-systems in the system.
- Social system has likely a tendency to slide towards chaos during the time of stress,

The General System Theory was used to study interrelationships and interactions between variables in Nyanza Region. According to Chandan (1997), some societies fail to

understand that organisations like schools are complex systems with components that are integrated and interrelated.

## **MATERIALS AND METHODS**

The study was conducted in Kenya, Siaya and Kisumu Counties. Kenya is found in East Africa. It has an area of about 583,000km<sup>2</sup> with a population of about 40 million. The location of Kenya is as follows: longitudes 34°E and 42° E; latitude, 4°N and 4°S. The area of study is found in Western Kenya on the northern, southern and eastern shores of Lake Victoria. The location of the study area in terms of longitudes and latitudes is as follows: longitudes 34°E and 35°E and latitudes 0° N and 1°S (GOK, 2013).

The philosophical underpinning to this study was that of pragmatism. Pragmatism prefers action to philosophizing. It endorses practical theory and what works the best in real world situation. It endorses pluralism. Pragmatism puts a high premium on human inquiry and equates it with scientific enquiry. It regards highly the reality of influence on inner world of human experience. In seeking to know how the parent and community determine learner's academic achievement, pragmatism advocates for use of a variety of methods in the enquiry so as to bring out a superior result as compared to where mono methods are used (Johnson & Onwuegbuze, 2004). In this study, pragmatism was applicable in the following ways: it allowed the use of more than one method in data collection. That is the questionnaires and interviews schedules were used to collect data.

The level of mixed methods approach employed was therefore qualitative and quantitative (Creswell, 2003). According to Johnson and Onwuegbuze (2004), the mixed methods approach is the third strategy in education research. It is defined as a class of research where the researcher combines qualitative and quantitative methods. It draws strengths from qualitative and quantitative method and minimizes weaknesses of both in the study. It also bridges the gap between quantitative and qualitative studies. Research has become complex, inter-disciplinary, and dynamic and there is need to compliment the methods (Cohen, Manion and Morrison, 2007). The strategy was meant to allow the researcher to mix and match the design components that offer the best option to answer

the research questions. It is a creative and expansive form of research and legitimizes the use of multiple methods of data collection. In this study, the method was to allow for use of words, charts and narratives to add meaning to the words. The numbers were also used to add precision to words and charts. The instruments used to collect data such as the questionnaire and interview guide was designed in way that it included sections which were open-ended questions and closed-ended questions (Cohen et al.,2007).

The study used cross-sectional survey where current perceptions, beliefs about academic achievement were collected from primary schools teachers' in Nyanza Region. The design of the study was descriptive survey which allowed large amounts of data to be collected over a short period of time. It provided for numeric descriptions of some part of the population. It enabled the researcher to describe and explain relationships as they are. It was chosen by the researcher because it is suitable where a researcher seeks to discover what really causes other learners to perform very well and others not to perform well. It also assisted the researcher to explore meanings, perceptions, associations, describe, explain the phenomena and observe relationships between independent and dependent variables. It assisted the researcher to collect data rapidly and understand the views of the population from part of it (Calmorin&Calmorin, 2007).Through the research design, the researcher sought to know from primary school teachers and head teachers in Siaya and Kisumu Counties how the community/parents determine academic pupils' achievement.

### **Target Population**

The target population was primary schools in Nyanza Region. Population is defined as the total collection of elements about which we wish to make some inferences (Cooper & Schindler, 2008). Unit of analysis was primary schools teachers`. Teachers were selected as respondents because they are the implementers of the curriculum and are able to provide required information regarding the objectives of the study. The head teachers were included as respondents because as Chief Executive Officers of the primary schools were also in a position to provide information about parent and community because they interact with the parents and the community mostly.

### Sampling Technique

The researcher employed probability sampling procedure. The sampling technique selected for the study was stratified random sampling. The sampling technique allowed for conducting of better interview, extensive investigation and processing of the data. Stratified random sampling technique was selected over the other probability sampling techniques because it increases samples statistical efficiency, it ensures that sub groups are proportionally represented; it accounts for some sub group characteristics (Cooper & Schindler, 2008; Krysik& Finn, 2007).

The primary schools in the region were grouped into counties and districts using the existing counties and administrative districts in the region. This was done to ensure equitable representation of the population in the sample. It further ensured that there was proportionate representation in the sample with a view of accounting for differences between the districts (Oso&Onen, 2008).

In the second stage random sampling technique was used to draw samples from each district. Table 1 shows how the sample was distributed among the different districts. The following process was used to draw the random sample:

- a. The list of schools in each district was acquired to serve as a sampling frame
- b. The names of schools as per the number assigned for the district were randomly picked through use of a computer

**Table 1: Sampling Frame of the Study**

County	District	Schools		Teachers	
		No	Sample	Head Teachers	Teachers
Kisumu	Kisumu West	145	15	15	54
	Kisumu East	56	6	6	22
	Kisumu Mun	162	16	16	58
	Nyando	75	8	8	29

	Nyakach	154	15	15	54
	Muhoroni	112	11	11	40
<b>Siaya</b>	Siaya	133	13	13	47
	Ukwala	76	8	8	29
	Ugunja	83	8	8	29
	Gem	110	11	11	40
	Bondo	131	13	13	47
	Rarieda	119	12	12	44
<b>Total</b>		<b>1356</b>	<b>136</b>	<b>136</b>	<b>493</b>

*Source: Provincial Director of Education Nyanza*

The sample for the study as shown on table 1 above was 10% of the population of primary schools in Nyanza Region (Kerlinger, 1983; Gay & Airasian, 2003). They suggest that for a descriptive survey, 10% to 30% is adequate. In each of the sampled schools, all head teachers participated in the study

### **Development of Instruments**

The study used questionnaires and interview schedules as the tools for data collection. The instruments were self-made. The instruments were selected because the researcher required detailed information which necessitated the use of multiple instruments to collect data in order to answer research questions.

### **Questionnaires**

The questionnaire was the main instrument used in the study. The questionnaires were selected because the respondents were able to read and the sample was large (Oso&Onen, 2008). There were two types of questionnaires used.

## **Interview schedules**

According to Calmorin and Calmorin (2007), interviews are used to collect information from respondents in order to arrive at a conclusion. The interview was designed in a way that it had closed and open ended type of questions in which probing was used to obtain more and deeper information. The researcher guided the interviewee through the interview process.

## **Validity and Reliability of instruments**

### **Validity**

#### **Face Validity**

According to Best and Khan (2006), face validity is the subjective judgment that the test appears to cover the relevant content. It also refers to the subjective judgment of assessors about what an instrument appears to be measuring, that is, on the face value. In this study, the instruments were presented to colleagues who made judgment on its validity. Their comments were used to make improvements on the instrument.

#### **Content Validity**

To examine the instrument on whether it had covered the content adequately, the instruments used in this study were subjected to an evaluation by colleagues who carefully and critically examined it and assessed the relevance of the items to the objectives of the study.

#### **Reliability of Research Instruments**

Reliability refers to the degree of consistency of an instrument; whether or not it can be relied on to produce the same results when used by someone else. In this study, the degree of stability was determined by comparing results of repeated measurements of the head teachers and teacher's questionnaires' and interview schedules for teachers. A pilot study was conducted in Rongo District which has similar characteristics to the study area.

The information gathered from the piloting was used to improve the instruments. The consistency of the questionnaire in measuring what they intend to measure was established by using the test-retest reliability coefficient, where the two sets of data obtained from the same group of respondents after two weeks during the piloting of the questionnaires was correlated using Pearson Product Moments Correlation method.

The correlation coefficient of 0.78 was attained for the teachers' instruments and 0.81 for head teachers' instruments. Since the reliability coefficient for both instruments was above 0.70, which is strong, the instruments were used to collect data for the study (Krysik & Finn, 2007).

### **Data Analysis Procedures**

The following section presents information on data analysis procedures especially how qualitative and quantitative data analysis was carried out.

The mixed methods approach was used in data analysis, the researcher combined both qualitative and quantitative approaches in the analysis of data. This improved the accuracy and validity of the research findings. The blending of the qualitative and quantitative approaches sought convergence of results, brought out contradictions, fresh perspective and produced a significance product which highlighted significant contributions of both (Johnson & Onwugubuzie, 2004).

The initial step in qualitative data analysis involved reducing dimensionality of the data. This was done by arranging the data in categories and themes. The research questions provided direction in the process of categorizing the qualitative data. The process of data reduction also involved editing, coding and classifying data collected through the following instruments: interview guide. The categories were mutually exclusive.

## **RESULTS AND DISCUSSIONS**

The study sought to investigate how the parent and community factors influenced pupils' academic achievement. The results were as presented in Table 2 below. Table 2 shows the descriptive analysis of data from Likert scale.

**Table 2 :Parent and Community Support**

	<b>Mean(head teachers)</b>	<b>Std. Deviation</b>	<b>Mean(teachers)</b>	<b>Std. Deviation</b>
Age of the parents has negative influence on achievement.	3.62	1.155	3.50	1.407
Community attitude towards curriculum influence achievement	2.91	1.318	2.80	1.412
Politics negatively affects achievement of pupils.	3.64	1.170	3.37	1.349
Lack of community imposition of high goals and standards on the pupils negatively influences achievement.	3.67	1.155	4.04	1.052
Community parenting style has negative influence on the pupils achievement.	4.22	0.899	4.22	0.894
Social gatherings such as discos have negatively	4.54	0.903	3.97	1.287

influenced pupils achievement.				
Compliance with learning time as specified by the curriculum	4.05	1.031	4.24	0.933
<b>Overall</b>	<b>3.8</b>	<b>1.056</b>	<b>3.81</b>	<b>1.16</b>

Table 2 shows that social gatherings such as disco were rated highly by head teachers as compared to teachers (mean = 4.54 and standard deviation = 0.903). This shows that head teachers viewed it as a major factor which influenced pupils` performance in primary schools`. The rest of the variables were rated averagely. This could suggest that teachers did not consider them to be very influential as compared to social gatherings held in the community such as discos. Poverty in the community was another variable which was rated averagely by both the head teachers and teachers. This could suggest that they both agreed that it was a contributor to poor academic achievement (mean = 4.44 and mean = 4.34 respectively). The average rating of poverty suggests that lack of adequate financial resources in the community could be limiting the parents` ability to support the personal needs of the learner such as acquisition of uniforms, provision of adequate meals, provision of additional text books and support for primary school infrastructural development. When pupils` personal needs are not met it leads to lack of motivation and truancy.

Poverty could also contribute to many parents withdrawing their children from school occasionally to participate in child labour such as sugarcane harvesting and selling merchandise during market days at Sondu, Ugunja, Ukwala, Yala, Dudi, Got Regea, Kisendo, Got Kokwiri, Manyulia, LwandaKotieno, Miwani and other markets in the region. According to 25(70%) of the teachers who were interviewed, they indicated that during market days many pupils were absent from schools as parents required them to

help them sell vegetables, fish, milk so that the parents can put food on the table. Children who don't take part in this activity may not get food at the end of the day. This encourages absentism and generally lack of commitment to academic work by the pupils. The teachers interviewed also indicated that some pupils in class seven and eight who are HIV/AIDS orphans and are being taken care of by guardians who are advanced in years are forced to absent themselves frequently from schools so that they can look for food for their younger siblings.

Table 2 also indicates that political activities had an influence on school activities (mean = 3.64). This was an average rating which could suggest that the teachers were not fully decided on this. This could also suggest that teachers mildly viewed political interference in the schools cycle of activities. For example, during election campaigns teachers wasted a lot of time in politicking at the expense of teaching. It also suggests that political upheavals experienced in 2008 in Kenya could have contributed to poor performance (figure 4.3) in the region in 2008 ( Kose, 2008).

Table 2 also shows that the teachers and head teachers rated the variable community averagely in the imposition of high learning standards (head teachers mean=3.67 and teachers mean=4.04). This suggests that the teachers viewed the community as not playing its role of setting learning/achievement standards for its children. If this is done, it could help the pupils to be self driven in their studies. The community could achieve this by organising itself so that it organises its own education days, develop community libraries and expose pupils to local models to inspire the pupils. This can help the schools to do very well in examinations. The results from the table further shows that community parenting style has influence on teaching and learning (mean = 4.22). This could suggest that community does not used appropriate parenting styles such as authoritativeness; use of other styles such as permissiveness encourages pupils to be less serious with their learning.

This suggests that parent community behaviours such as allowing social gatherings such as discos/dances and the parenting styles have influence on pupil achievement. They

encourage absenteeism and lack of concentration in schools by pupils.

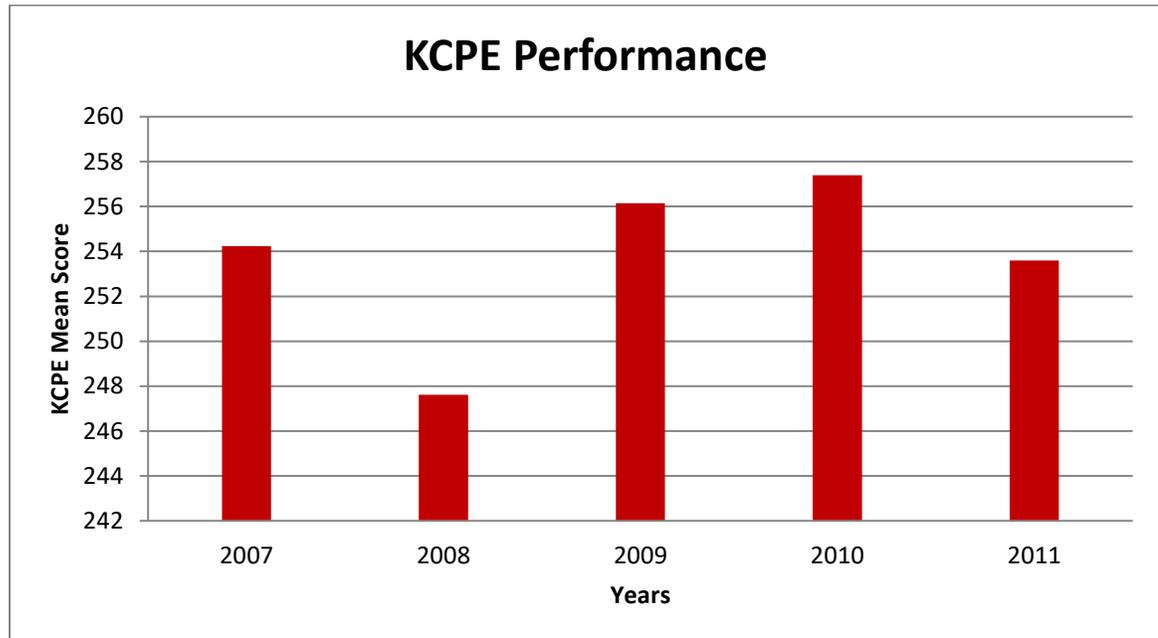
These findings confirm assertions in the General Systems Theory that there is dependence of the organization on its environment. The school system depends on the community to provide it with pupils who are well behaved and disciplined. If this is not done, the school will have very poor raw materials to work with and results will be poor.

These findings indicate that the community and parents have profound influence on achievement of schools. This can be observed from the strong agreement among the respondents (table 2). This shows that teachers on their own cannot do much without the support of the parents. It is the responsibility of the parents to acquire for the pupils facilities like books which are not provided by the school.

In the interview conducted by the researcher, 36(100%) majority of the teachers indicated that many parents could not control their children, this contributed to high rate of absenteeism especially during market days. This high rate absenteeism affected pupils' achievement. They strongly felt that the head teacher needs to work with the community to solve this problem.

## Performance in Kenya Certificate of Primary Examinations

The study also sought information about primary schools' performance in KCPE between 2007 and 2011.



**Figure 1: KCPE Performance results 2007 to 2011**

Figure 1 shows that mean marks for KCPE were: 254 for 2007; 247 for 2008; 256 for 2009; 257 for 2010, and 253 for 2011. The figure also shows that schools' performance in KCPE was highest in 2010 with a mean of 257.38; the poorest performance was in 2008 with a mean of 247.60. Figure 4.4 indicates that the performance of KCPE in Kisumu and Siaya counties has been fluctuating over the 5 year period. This finding about KCPE results in 2008 is linked to average/high rating of the political activities (table 2) to be influencing pupils' achievement. This suggests that during the post-election violence of 2008 teachers could have been engaged in politicking at the expense of teaching. It could also suggest that the class of 2007 was not adequately prepared due intense political activities which took place that year.

These findings are consistent with observations made by Mose (2008) who indicates that the post-election violence of 2007 to 2008 greatly affected learning in Kenya. It was especially intense in Central Nyanza Region. According to Omolo (2010), Luo-Nyanza used to be academic powerhouse from independence up to mid 90`s. Pupils` from primary schools` in Nyanza were always ranked among the top in the country. Since then, the performance has dipped. It is only very few schools which appear among the top primary schools in the country. In order for a school to be top ranked in Kenya, the primary school must attain a mean score of 390 and above.

The findings on Table 2 are consistent with observations made by Wanyonyi (2010) who indicates that socio-cultural activities in the community such as discos, weddings and burials can have a negative effect on education. Similarly, Keriga and Bujra (2009) observe that it is the responsibility of parents to provide pupils with basic needs such as food, uniforms and learning materials. Moreover, Otieno, 2008 and Omolo, 2010) indicates that academic achievement of primary schools can be affected if there are political and religious interferences in the management of primary schools by the community. They observe that clanism can also be a major problem in the running of schools especially when the community prefers their own to be the head teacher.

Majority 30(83%) of the teachers interviewed asserted that social events such as discos affected pupils learning in the following ways; many pupils who attend social gatherings such as discos are tired by the time they come to school. It also contributes to sex escapades which affect female pupils; moreover, pupils do not have time do assignments.

## **CONCLUSIONS AND RECOMMENDATIONS**

### **Conclusions**

Arising from the findings, it can be concluded that parents and community have been a determinant of achievement in primary schools in Nyanza region due to: poor control over their children by allowing them to attend social gatherings such as discos when

schools are in session, this promotes pupils absenteeism from school as they are tired the next day and cannot concentrate in their lessons. It also contributes to pupils dropping out of school as some become pregnant after engaging in sex during such events. Poor provision of educational materials required in primary school curriculum implementation by parents such as classes at the expense of their children's academic achievement has also contributed to poor academic achievement. It can further be concluded that the relationship between community/parent variables also contributes to poor pupils' achievement. It can further be concluded that the dominant community/parent variables which affected primary pupils' academic achievement were community parenting style and social gatherings.

### **Recommendations**

Arising from the findings and conclusions that have been made, the following recommendations can be made: The community should be sensitized about the need to support schools by providing human/physical resources which are inadequate such as: Putting up classrooms, Hiring additional teachers, To provide quality facilities like desks, To provide instructional materials. The social gatherings such as discos conducted when schools are in session, which interfere with pupils' learning and achievement should be controlled. The discos which are mostly held when there is a funeral in the community should be controlled in a way that only people who have completed school are allowed to attend this event, which is normally held at night. During such nights many young people engage in drinking and sex activities which derail their ability to focus on their studies. The community and teachers should work together to ensure that pupils join primary education at appropriate age and sit for KCPE at an appropriate age (14-15yrs) for them to perform well in KCPE. To control pupils' absenteeism, the community to address things which contributes to pupils' absenteeism such as child labour, they should avoid using learners during school days to sell merchandise in markets. The Community should identify alternative economic activities to involve pupils and which will not interfere with pupils' education. Aged parents/care giver/guardians that may not be able to control the children under their care but are in primary schools should be assisted to do so. School related variables which influence

pupils' absenteeism such as teacher absenteeism should be addressed. Child friendly schools concept should be aggressively implemented to enhance good teacher/pupil interaction. Head teachers should hire experts during parent meetings in the schools to educate parents about the following; Parenting style, adoption of parenting styles suitable to the personality of each of their children. The community should address poverty related issues which causes absenteeism such as lack of: food, text books.

### **Suggested Areas for Further Research**

Studies should be carried out to investigate Parents' apathy towards pupils learning in primary schools.

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## **Preparing Faculty for Utilization of Innovative Approaches in Digitalized Teaching and Learning environments**

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### **ABSTRACT**

The emergence of new information and communication technologies that can be used to enhance teaching and learning environments provide both an opportunity to transform delivery of education and a challenge in its adoption. With the proliferation of portable and adaptable technologies, it is currently possible to access educational content anywhere with internet connectivity. This has heightened the interest for online learning and most academic institutions now provide options for both face -to- face and electronic leaning. Hence the need arises to prepare faculty to adopt the emerging approaches in teaching as they integrate technology in the delivery of instruction. The learners also need orientation in order to adapt to the virtual and online learning environments. An important factor in the success of managing online instruction is the training of faculty before launching online courses and provision of support throughout the study. The emphasis placed on training of faculty for online instruction, will determine its success or failure. It is important to determine and address the needs related to online instruction appropriately. With the dynamic technological advances, it is critical that faculty are updated on new learning devices in order to provide learners with interactive, rich and engaging online content. There is need to rethink teaching and learning as we embrace innovative approaches such as utilization of e-learning platforms, social media, you-tube, open educational resources, initiating collaborations and partnerships with industry and educational institutions. Integration of information and communication technologies into teaching and learning offers significant potentials for higher education institutions resulting in transformations in delivery approaches and presentation of content. This paper is based on the experience of training and supporting faculty and students at institutions of higher learning. It explores innovative approaches that enhance instruction and highlights the challenges faced by faculty when transforming roles from face-to-face teaching to managing digitized learning environments.

**Keywords:** E-Learning Technologies; Online Instruction; Digitized Teaching; Course Design

## **INTRODUCTION**

The world today is driven to a large extent by Information and Communication Technologies (ICT). The proliferation of these technologies in the work place, learning environment, sport and entertainment arenas is a clear indication of their significance. Different sectors have integrated technologies in their service delivery and task performance to varying degrees. However, the bottom line is that the operational environment has gone digital and the devices metamorphose at amazing speeds. This therefore implies that continuous exposure to the emerging information and technology devices, development of digital skills and literacy are imperative for effectiveness and efficiency in all our day to day undertakings, otherwise there is risk of digital exclusion.

Training and support of faculty is an important factor in the success of running online instruction. As faculty venture into the online learning realm, they require support to make the transition from traditional classrooms to online instruction (Johnson, 2003; Pelz, 2004). The emphasis placed on training of faculty for online instruction will determine its success or failure. It is important for those responsible for online support services to assess faculty deficiencies in terms of technical and pedagogical skills in order to determine the needs related to online instruction. There is need to rethink teaching and learning for the online environment in order to cater for the online learners' unique environment in which they are working, which includes both the virtual classroom and their off-campus world.

Integration of information communication technologies into teaching and learning offers significant potentials for higher education institutions and new challenges for faculty as they venture into the digital realm. There is therefore a need for faculty to acquire new skills and enhance their capacity to facilitate the new kind of instructional approaches in the digital environments.

## **OBJECTIVES**

This paper was based on the experience of training and supporting faculty at institutions of higher learning. The objectives were to:

- ❖ determine the attitude of both the instructors and learners towards online learning

- ❖ establish the challenges faced by faculty when changing roles from face-to-face teaching to managing online classrooms.
- ❖ To identify the skills gaps to be addressed for effective implementation of online teaching and learning.

## **METHODOLOGY**

The data was collected during the training sessions. Questionnaires (Pre and Post training) we administered at the beginning and end of each training session. In addition, the behavior of the participants was observed throughout the training period, checking on questions asked, requests for support during practical sessions and reactions to information provided. At the end of the training, the data was analyzed and compared.

We sought through the questionnaires to determine the attitude, literacy levels with regard to the technological applications such as navigation within the eLearning platform, identifying useful instructional links on the Internet and integrating the information for instruction, appropriate instructional strategies and the skills gap with regard to the devices and tools for application. A sample of the questions asked included:

a) Pre-training Questionnaire

- Have you heard of online/eLearning?
- Have you used an eLearning platform to teach or study?
- Please indicate your level of ICT literacy (Basic, proficient etc.)
- How do you use Internet?
- What are your expectations of this training?

b) Post-training Questionnaire

- How did you find the services provided for this training?
- How would you evaluate the relevance of the issues discussed in the presentations?
- Please rate the following statements after this training: I have a better understanding of - (a) online/ eLearning, (b)distance education, (c) Self-Learning Instructional Materials (SLIMs) (d) Learner/ Content

Management Systems (LMC/CMS), Support services, Discussion / chart forums.

- Are you now ready to offer your courses online? If no please elaborate.
- Would you require more training? If yes, suggest areas for further training.

## **RESULTS.**

The results were categorized into three broad areas namely attitude related, technological and pedagogical challenges. In most cases, those being introduced to online learning for the first time were skeptical that real learning with intended outcomes could be achieved through such approaches which were not conventional. The attitude was even more negative for those who had challenges in utilizing the technological devices which formed the media for delivery of instruction. Finally, the innovative approaches possible under the virtual learning environments meant that the instructors had to learn new approaches of delivery simultaneously with learning new skills on how to utilize the emerging digital devices and applications.

## **ATTITUDE OF FACULTY**

A majority of the lecturers who have attended the training sessions carried out in a number of higher education institutions in East Africa indicated that they have neither taught nor undertaken online courses for credit. However, as these institutions begin to embrace online teaching, the level of anxiety and uncertainty have remained high, sometimes leading to resistance to change or total rejection. Faculty were divided about whether courses delivered online can achieve the same learning outcomes as those delivered face-to-face. Some still view online teaching to be less effective than traditional classes when it comes to interaction with students during class. Other faculty members also expressed the view that online courses may be especially ineffective when it comes to teaching of hands-on or practical courses that require skill transfer.

Some of the faculty members further expressed a general feeling that creating and uploading learning content online would provide avenues for accessibility by anyone and can be downloaded to be used elsewhere. They felt that they would be expected to put too

much effort in the design and development of the instructional content, for others to access freely disadvantaging them. Some doubted the employability of the graduates of online learning systems, questioning their competence.

It emerged however, that after exposure through training, faculty developed a strong sense that online instruction is a way to enhance one's teaching skills and increase student engagement with the learning materials. They further expressed that it helped them organize their work for efficient and effective delivery of instruction. This approach accorded the flexibility especially with regard to delivery time and were no longer tied to a specific location. It was notable that faculty eventually admitted that online classes were more effective compared to traditional classes when grading, communicating and monitoring individual students at a personal level.

From our observations of the participants, we found that at the end of the training sessions, and with further continuous exposure and support, the attitudes of the faculty slowly changed and they became positive towards electronic/ online teaching. Some would even go ahead to offer to be champions in their schools to lead and convince others to embrace online teaching and learning. We therefore encouraged peer support urged them to form teams in their journey as they designed, developed and delivered instruction online. The transformation became a motivating factor in itself and we began getting positive responses and requests for training from those who had initially declined to participate.

## **TRAINING OF FACULTY**

Training forms the most critical foundation in the development of competence for online delivery of instruction. There is therefore a need to provide both formal and informal training opportunities to faculty in order to advance and also accelerate the integration of technology in their delivery of instruction. Informal training sessions can be organized through competent liaison staff who are attached to different schools to provide support during the semester. This provides for continued contact between faculty and training teams for sharpening of skills and providing support when students interact with online

materials.

A training almanac can be provided at the beginning of the semester and shared with schools who schedule themselves to attend training as per the dates provided.

Essentially, the training is tailored to provide the lecturers with basic skills to enable them become proficient in navigating through the learner/content management system.

The training is inclusive of a number of topics, such as, how to design online instruction, how to effectively engage students, how to manage discussion forums and learning how to handle new digital devices and applications. At the beginning, it is imperative to do sensitization for the first-time participants. This provides an opportunity to transform minds and eliminate negative attitudes from pre-misconceived perceptions about e-learning.

Practical sessions provide the participants with a tangible experience on what to expect whenever they access the learner/ content management system. Apart from support on how to upload content, faculty are taken through the learner profiles to have an experience of what a student encounters while interacting with instructional content.

All limitations attributed to an online learner are highlighted for faculty to consider when designing online instruction and avoid activities that could pose a challenge to the learner's experience while using the learning management system. A step by step procedure for including activities and resources putting into consideration pedagogical skills is undertaken to create quality interactive online course. A manual should also be provided both in print and on the eLearning platform.

As a result of the exposure through training sessions, a majority of faculty become eLearning champions in their various sections. This is because faculty tend to listen to other faculty rather than the instructors, providing a forum to share what worked for them at different times when faced with challenges.

With the growing range of roles and responsibilities, faculty need to engage with ongoing skills upgrade at every opportune moment. However, during the sessions it was evident

that faculty have competing priorities. Finding time for multiple work responsibilities was an issue of concern for all faculty. Faculty members were also concerned about how to achieve balance as they handle personal as well as professional commitments. This resulted in participants dropping out from the training sessions or walking in and out of training rooms hence missing out on critical aspects of the training.

It was established that some faculty who were very vocal about their course not being able to be adapted for online teaching, had a challenge with using the attendant technological devices. The reason was attributed to an individual never having had a chance to use technology while undertaking their education and what was being introduced was unfamiliar territory.

Issues of copyright and how much is acceptable material to be used from other sources was an issue. Faculty had a feeling that their developed content would be accessible to everyone and others would publish their materials without their knowledge. Another major issue of concern that downplayed on the morale of faculty was on compensation. There was concern about the time an individual would take to develop self-learning materials and the compensation.

## **FACULTY SUPPORT**

The technical support team remains to be a great asset to the success of the online class once a course has been launched. The team responds quickly to the technological hitches and unexpected issues that may arise. This support provides a positive student experience and ensures that faculty feel that they have a recourse where their challenges can be addressed. Their confidence level motivates them to continue teaching online.

Faculty who are supported fully by the technical support team and management become effective champions for online teaching and learning and can provide peer support to their colleagues. According to Vai and Sosulski (2011: 4), “a great deal of work and research has been done to determine what works in an online learning and teaching environment. As a result, standards and best practices have been developed to guide course designers and teachers”

Once the course has been launched, students are given basic orientation on the Learner management system and enrolled in the course. Faculty at times would be enthusiastic about online learning and would want to roll out an online course without prior preparation. This sometimes leads to a number of challenges since there would be no resources in form of instructional content or activities that would engage the students asynchronously. Challenges also emerge if there are no provision for students to participate in discussion forums, online chats or submit their assignments.

In managing Students, enrolment into courses proved a challenge especially for large classrooms. This was either due to students missing out during the orientation sessions or not keenly following instructions as guided. A Lecturer would have an afterthought of having the students in groups for easy management and assessment for the large classes. This needed manual allocation of groups on the system that would result in a student having registered in more than one group or would want to change groups after allocation had been done.

## **INNOVATIVE APPROACHES TO DELIVERY OF EDUCATION**

There is need to have a strong understanding of how to navigate through the learning management system. Knowledge of other web technologies and how they function would provide leverage for instructors in presenting their content well. Faculty need to take advantage of opportunities for training and workshops, collaborate with colleagues who are currently teaching online, and request consultations with specialists. Some of the innovative delivery approaches include: e-Learning Teams; Open Educational Resources; Collaborative partnerships; Social Media Platforms; Flipped learning; Blended Learning; Student-led discussions; Cooperative Learning; Problem-based Learning; and Project-Based learning. A number of the innovative approaches are addressed below.

## **USE OF OPEN EDUCATIONAL RESOURCES**

Open Educational Resources (OERs) are any type of instructional materials or content that are in the public domain or introduced with an open license. The nature of these open

materials is that anyone can legally and freely copy, use, adapt and re-share them. OERs range from textbooks to curricula, syllabi, lecture notes, assignments, tests, projects, audio, video and animation. These materials can be used by an individual to enhance their knowledge and training, as well as by students and educators around the world. Open Educational resources encourage more independent and flexible learning opportunities for students. The courses allow students to explore materials before enrolling, making them better prepared before they arrive in the classroom.

Leading universities around the world provide free online courses that are open to the public. This provides for easy access to more quality choices of courses for students in low-resource environments enabling the enjoyment of recorded lectures and video tutorials. Just to name a few reputable institutions such as; Yale University – <https://oyc.yale.edu>, Massachusetts Institute of Technology – <https://ocw.mit.edu/index.htm>, Harvard University – [www.extension.harvard.edu/open-learning-initiative](http://www.extension.harvard.edu/open-learning-initiative), are among the many colleges and universities offering open online courses to the public. Educators share their work with more individuals and enjoy wider influence since their materials are available to larger audiences.

Through provision of a free license, educators can improve and adapt the learning materials to give students what they need to learn to achieve their goal. New programmes that have been introduced at some universities especially in the developing economies, lack adequate learning resources that would provide insightful learning to students. In one of the training sessions students were more eager to supplement their classroom learning with OERs which were available freely online. One of the participants highlighted that the recommended text books for their course were highly priced and hence not affordable. The participants were therefore glad to discover the vast resources available for use free of charge.

## **BUILDING E-LEARNING TEAMS**

E-learning teams are collaborative groups of lecturers with the intention to improve their teaching methods and increase students learning. These teams provide a forum where

challenges encountered and success stories are shared thus diffusing the negative attitude towards online instruction. The main benefit of e-learning teams is the opportunity for collaboration, peer mentoring, and support in the process of designing, developing and delivering online courses.

It is easier to interact constructively and support each other more effectively for an e-learning team when in smaller groups of about ten (10) members. The members in the team get to know each other well enough to understand their strengths and weakness and agree on a common framework of operation. This minimizes conflict and enables the team members to derive value from the collaboration. To run the team efficiently, roles should be assigned to members to provide coordination among themselves and any other eLearning support services that they can access. The team should create opportunities for regular interaction to enhance moral support and tackle any challenge that may arise in the course of rolling out the online course.

### **COLLABORATIONS AND PARTNERING WITH OTHER INSTITUTIONS**

It is important to partner with institutions that have had success in implementing online teaching. Faculty have the opportunity to share ideas and learn from different experiences. From observations gathered at a number of universities in the region, it was evident that the challenges experienced were similar to a greater extent in terms of workload, attitude, infrastructural, pedagogical and technological challenges. There was reluctance from lecturers to take up online teaching citing reasons such as too much workload and not having received adequate training for them to be proficient. Issues with compensation and facilitation from management on availing resources for developing online materials were highlighted as barriers to embracing online teaching. Another issue of contention was on the ownership of copyright for the Self-Learning Materials (SLIMs) designed and developed.

### **E-LEARNING PLATFORMS**

The type of eLearning platform an institution selects will depend on the programme content they want to be delivered online. That, in turn, depends on a number of factors

such as the curriculum, what students should know and be able to do as they navigate and interact with the platform, technical devices and applications and the skills of online instructors. Unique requirements for delivery of content for online courses, is a major challenge when selecting the right eLearning learning platform. An institution will need to focus on the learner and the outcomes they must obtain from progressing through the online courses. There should also be consideration on the features that will be required to deliver the instruction. All learning management systems contain an array of features. One may consider some 'must have' features such as analysis of learner outcomes, a chat space for learners, or the ability to carry multiple content formats from text to videos, and those elements necessary to dispense the content seamlessly, and intuitively, to learners.

There is need to understand the technical skills of those who will be using the system keeping in mind how and when they will access the system. Today, the digital instruction is mostly asynchronous, meaning it takes place on-demand rather than during scheduled times and in defined locations. Therefore, it is important to ensure that the learning management system selected has a mobile capability, for learners to have constructive and productive experiences whether on a desktop, tablet, smartphone or any other digital device. For any new system and applications installed, training must be provided for the users to familiarize themselves for greater proficiency leading to maximin utilization.

Commercial Learner Management systems sell through a subscription and come ready to use. The provider handles any technical problems and maintenance and performing scheduled visits to carry out software updates. An open source system may be a better solution for institutions that have in-house software developers and are able to customize the Learner Management System to accommodate their unique requirements. An open source LMS is sold with partial coding that the purchaser must complete before use. This therefore means that the institution must invest in system developers to support and maintain the system. For a cloud based LMS, the software resides on a remote server maintained by the vendor. This type of LMS deploys via a browser, and customers are charged a subscription fee. An on-location LMS is installed on the purchasing company's server. Buyers typically pay an annual license fee and are charged for other installation

and support services if required. Factors to consider include the size of your organization, the cost, how customized the learning environment must be, and the data security.

The possibility of institutional growth, with more courses of different types and varying cases of use will have an effect on the LMS capability of expansion. Online learning is growing fast and becoming not only more accepted but more expected, hence the Learning Management System must be flexible enough to seamlessly adapt to the anticipated learning opportunities that continue to emerge.

### **USE OF SOCIAL MEDIA PLATFORMS**

Social media is a group of internet-based applications that build on the idea and technology foundations of web 2.0 which allows creation and exchange of user-generated content. Social media has gained credibility over the years as a trusted source of information and platform where organizations can interact with audiences. The use of social media in education provides students with the ability to get more useful information, to connect with learning groups and other educational systems that make education convenient. The social network tools afford students and institutions with multiple opportunities to improve learning methods. Through these networks, one can incorporate social media plugins that enable sharing and interaction. Students can benefit from online tutorials and resources that are shared through social networks and content management systems.

Social platforms such as Facebook, YouTube and Instagram are being used to communicate campus news, make announcements and provide students with useful information. This has built engagement between the institutions and students which help in addressing many student issues through the group interactions. Video is a prominent tool on social media that is effective and can be used to share useful videos that inspire students and help them in enhancing the understanding of their course content. Twitter as a social platform through the use of the hashtags has been used to engage students in online discussions that are helpful.

Social media offers audience and subject monitoring tools that are useful and it is one of the best platforms to extract data. Students can find out how the majority of people feel about a particular topic or how experts perceive and advice on specific issues. This can help students compile and produce useful content for research. Whether students are working on an assignment, working on a project or trying to gain more insight on a subject, some of the best information and results can be extracted from social media.

Connecting with experts on topics through social media is made possible at amazing speeds. These provide a great opportunity to interact and engage instantly with experts on various subjects and receive immediate responses to questions and guidance on topics that one may require support. Social media has the ability to broaden student's perspectives on various subjects and avails new informative materials.

## **CONCLUSION**

Institutions of higher learning should embrace the emerging digital technologies by integrating them into their teaching and learning systems and ensuring that both the instructors and learners are trained on a continuous basis to keep them competent and updated. This will lead to positive attitudes, greater levels of technology integration and higher motivation levels. In addition, they need to capture the benefits offered by emerging digital technologies that support online instruction and embed best practices in their teaching and learning culture to enhance quality and greater participation of the learners. Thus, there is need to keep abreast with the technology as it evolves hence the need for frequent reskilling and training of both faculty and students. It is also critical to pay attention to the ideal choice of the e-Learning platform and professional design and development of instructional content. The bottom line is not the utilization of technology or not which makes the difference. It is how efficiently and effectively the technology is used to support teaching and learning that results in the achievement of the desired results.

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# **Effect of Strategic Direction on the Performance of Technical Training Institutions in Meru County, Kenya**

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## **ABSTRACT**

Organizational performance is important in justifying its existence and resources allocation. To enhance performance, Strategic direction has been identified as useful in promoting organizational performance. For Technical Training Institutions to achieve their core mandate in human resource training, the Government has emphasized on their development and implementation of strategic plans. Technical Training institutions have been operating with strategic plans for at least the last ten years; however no systematic study has been carried out to investigate the influence of these strategic plans on the performance of the institutions. The current study sought to investigate the effects of the strategic direction on performance in respect to enrolment, resources, quality and efficiency. The study used the cross sectional descriptive survey research design. Questionnaires were used for data collection. Instruments were tested for reliability by use of the cronbach's alpha and a correlation coefficient of 0.75 was obtained. Validity of instruments was ensured by use of peer reviewers and research experts. The researcher personally administered the instruments; this helped in realizing a high return rate. Data was analyzed by use of both descriptive and inferential statistics including frequencies, percentages, means and the regression analyses and presented by use of tables and figures. The study established that the strategic direction had significant influence on the performance of technical training institutions. The introduction of the government policy has a moderating variable improved the model on organizational direction. The researcher recommends the alignment of the institutional philosophy, priorities, innovations and collaborations to the institutional strategic direction which could improve the performance of Technical Training Institutions.

**Keywords:** Effect, Strategic Direction, Performance,

## **Introduction**

Strategic planning is a deliberate process to envision the future and develop plans for interacting with the competitive environment to achieve that future (Pearce & Robinson, 1995). Strategic planning is an organization's process of defining its direction, and making decisions on allocating its resources to pursue this strategy. According to Byars (2001) a strategic plan is used to describe the steps taken by an organization in achieving its objectives and mission. In addition to this, Starkey (2004) points out that the mission is the first step of the strategic plan that defines the long-term vision of the organization. If an organization does not have a vision, then there is no reason for existing. Henry (2004) argues that this is the process for creating and choosing a particular strategy to respond to future events and plan how to implement it.

The concept of performance is vital in all organizations whether commercial; profitmaking or Not-for-profit organizations, private or public sector (Johnson, *et al.*, 2008). Organizational performance is a measure of the extent to which the organization's goals and objectives have been achieved. Such measure of achievement informs all the stakeholders of the extent to which organizations are succeeding in their business. Based on their object and context, different organizations use different modes of performance. Mazzarol and Rebound (2009) notes that, organizational performance can be measured as achieving sustainable growth over time using such indicators as annual turnover, the number of employees, size of assets and equity in the balance sheet, market share and profitability. However, Bolo, Mutoria and Oeba (2010) observes that firm performance refers to how well or badly a firm is performing both financially and non-financially thus exclusive use of financial achievements or indicators as the sole yardstick to determine organizational performance would be biased because organizations desire to achieve broad objectives. Kaplan and Norton (2008) suggest that, use of a balanced scorecard for measuring company performance that tracks the achievement of both financial objectives and strategic objectives is critical.

Measurement of performance in educational institutions will therefore include academic excellence, land infrastructure development, discipline and school culture, quality and relevance of graduates to market skill needs, stakeholder satisfaction, financial stability and excellence in non-academic activities (Okwako, 2013). This is in conformity with Denison (2006) who argues that modern approaches in measuring performance should consider all aspects in the organization. Firm performance is therefore a very essential aspect of a firm because as March and Sutton (1997) puts it, performance comparisons become a basis for evaluating executives, making decisions about resource allocation of human and other

resources, for writing history and for stimulating arrogance and shame.

The desire for Strategic plans in Kenya commenced slowly and gradually back in the 1960s but has presently gaining currency and popularity (Yabs, 2007). The public sector finds the concept of strategic plans just as important as in commercial firms and hence Technical Training Institutions in Meru County are required to formulate strategic plans in tandem with the MoE's strategic plan in order to foster the government's agenda to provide trainees with the quality education and training (Birgen, 2007). Strategic plans are expected to positively influence performance by enhancing the financial and non- financial outcomes in the training institutions. This makes the strategic plans a necessary management tool for Technical Training Institutions in Meru County if these institutions are to justify their public financial support and produce graduates that help in meeting the country's development vision.

A number of scholars such as Cole (2004) and Ansoff (1990) have argued that there is a positive correlation between strategic planning and performance while others argue that the relationship between planning and performance is inconsistent and thus still debatable (Barney 2007, Thompson et al, 2007). There have been studies on influence of strategic planning on performance in other education sectors. For instance, Mukokho (2010) studied the influence of strategic planning on performance of public universities in Kenya, the case of university of Nairobi, Gode (2009) studied influence of strategic planning on the performance of public secondary schools in Kisumu East, Ayieko (2011) studied strategic planning practices and performance of manufacturing firms. The above studies recommended for the development of strategic plans to enhance performance in the studied sectors. A study of strategic planning and performance in public secondary schools in Rarienda District by Okwako (2013) indicated the importance of strategy planning in public secondary schools and therefore suggested a replication of the study in different parts of the county and other levels of education. Despite the critical role that the Technical Training Institutions play in human resource training and the concern raised with regards to the quality of graduate, the enrolment levels and resources in these institutions, the sectors seems to have been ignored by researchers which shows a knowledge gap that needs to be addressed. Do strategic plans influence performance in Technical Training Institutions in Meru County? The current study sought to determine the effect of strategic direction on the performance of Technical Training Institutions in Meru County.

## **Research Hypotheses**

**H<sub>01</sub>:** There is no effect of strategic direction on the performance of Technical Training

## Institutions in Meru County.

### **Methodology**

The study used cross-sectional descriptive survey research design. The target population for the study was the 90 members of management in the three technical training institutions in Meru County. All the three technical training institutions (Meru National polytechnic, Nkabune and Kirua Technical Training Institute) which have implemented a strategic plan for atleast one complete cycle in the county were used for this study. The management of the training institutions participated in the study. These included the top management, made up of the Principal, the two deputy Principals, the finance officer and the registrar, the middle level management made up of the heads of departments and the dean of students and the lower level management, made up of the heads of sections participated in the study. All the 90 subjects participated in the study.

Primary data was collected by use Questionnaires. Structured and unstructured items were included in the questionnaire. The questionnaires were administered to the top management, middle and lower level management. Closed ended items were categorical and likert scale format. To ensure the validity of the instruments, the researcher involved peers and research experts in the department of business in Kenyatta University. The researcher personally administered the instruments to the respondents. The data was analysed using both descriptive and inferential statistics. A regression analysis was conducted to establish the effect of the independent variable on the dependent variable.

### **RESULTS AND DISCUSSIONS**

#### **Demographic Characteristics of Respondents**

An item was included in the instruments that sought information on the duration that the respondent had served in their current management positions. This information is presented in Table 4.1.

**Table 4.1 Duration served in the Current Position**

Duration of service	Frequency	Percent
<2 years	22	17.7
2-3 years	20	16.1
4-5 years	19	15.3
>5 years	61	49.2
Total	122	98.4

Information in Table 4.1 indicates that 49.2% of the respondents had served in their current position for over five years whereas 17.7% of the respondents had served for less than two years in their current positions. Having 49.2% of the respondents who had served in the institutions for more than five years means that respondents had experienced the planning and implementation of the strategic plans which was critical in the current study.

The researcher sought information on the academic qualifications of the respondents. The responses are presented in Figure 4.1.

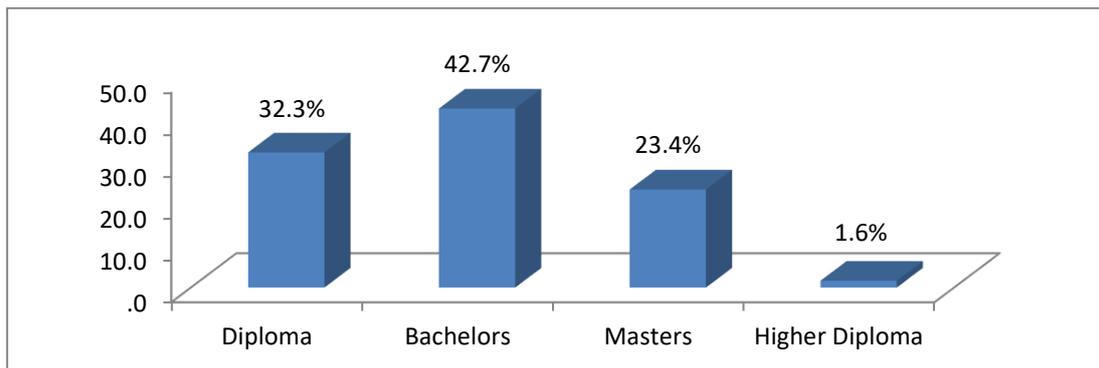


Figure 4.1 Academic Qualifications of Respondents

Information in Figures 4.1 shows that 42.7% of the respondents had a bachelor's qualification while 32.3% had a diploma qualification.

### Competency levels in Strategic Planning

The researcher further sought information from the respondent on their self-rating on competency in strategic planning. This information is shown in Table 4.2.

Table 4.2 Competency Level

Responses	Frequency	Percent
Very competent	18	14.5
Competent	44	35.5
No Opinion	24	19.4
Incompetent	1	.8
No response	37	29.8
Total	124	100.0

Information in Table 4.2 shows that 35.5% of the respondents rated themselves as competent while 19.4% of the respondents held no opinion on their levels of competence in strategic planning. Only 14.5% of the respondents indicated that they were very competent in strategic

planning.

### Development of the Strategic Plan

The researcher sought information on who developed the institutional strategic plans for the Technical training Institutions. This information is presented in Figure 4.2.

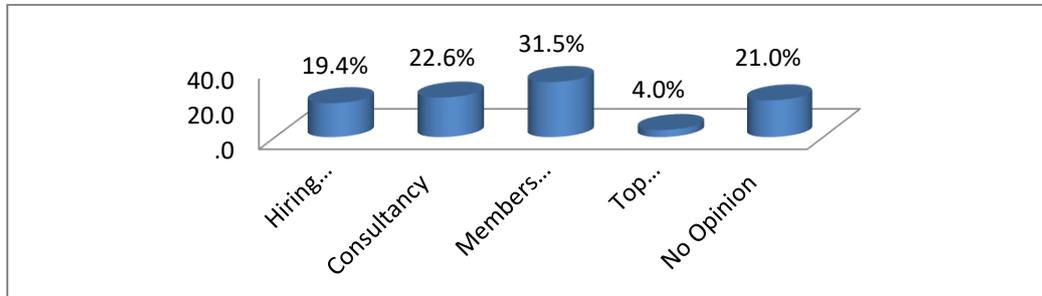


Figure 4.2 Development of the Strategic Plan

Information in Figure 4.2 shows that at 31.5% respondents indicated that strategic plans were developed by the members of staff within the institution whereas 22.6% indicated that the institution used skilled staff on consultancy bases for the development of the strategic plans. Respondents at 19.4% indicated that institutions hired professional experts for the development of their strategic plans.

### Descriptive Statistics

To achieve the objective of the study on the determination of the effects of the strategic direction on performance the researcher sought information on various dimensions of the strategic plan. The likert scale with a five level scale where 1 – no extent and 5 very great extent was used. Descriptive statistics of the mean and standard deviation were used to analyze the results. This information is presented in Table 4.3.

**Table 4.3 Organizational Direction**

Organizational Direction	N	Mean	Std. Deviation
Mandate	124	4.03	.569
vision	124	4.15	.404
mission	124	4.10	.400
philosophy	122	3.90	.536
goals	124	4.12	.374
objectives	122	4.20	.444
priorities	124	3.94	.810
<b>Overall mean score</b>		<b>4.07</b>	<b>.505</b>

The results in Table 4.3 yield an overall mean score of 4.07. Organizational objectives

dimension of the strategic plan had the highest mean score (mean score=4.20, SD=0.444). Two dimensions were rated lowest philosophy (mean score=3.90, SD=0.536) and priorities (mean score=3.94, SD=0.810). This means that the dimensions rated highest are those that respondents could be able to relate directly with the strategic plans. There is need for the institutional managers to align the institutional philosophy and the priorities to the institutional strategic plans.

### Government Policy

The researcher sought information on the extent to which the Government policy being a moderator variable impacted on the institutions' strategic plan. This information is shown in Table 4.4.

**Table 4.4 Government Policy**

Government Policy	N	Mean	Std. Deviation
Accountability	122	3.98	.966
stability	120	3.84	.879
Effectiveness	120	3.82	.869
Regulatory quality	122	3.97	.852
Rule of law	122	3.95	.822
Control of corruption	122	3.90	.885
<b>Overall mean score</b>		3.91	.879

Information in Table 4.4 shows that the government policy impacted to a great extent on the strategic plans. Accountability (mean score=3.98, SD=0.966) and Regulatory quality (mean score=3.97, SD=0.852) were most important in the institutions strategic plans. Effectiveness (mean score=3.82, SD=0.869) and stability (mean score=3.84, SD=0.879) were rated least important in the strategic plans.

### Performance

To achieve the objectives of the study, the researcher sought information on the performance of technical training institutions. Various indicators were used to assess the extent of performance by the Technical Training Institutions. This information is shown in Table 4.5.

**Table 4.5 Performance**

	N	Mean	Std. Deviation
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Quality	124	4.22	.657
Quality of trainers	124	3.91	.884
Quality of infrastructure	124	4.01	.888
Quality of training tools	124	3.75	.976
Quality of curriculum	122	3.87	.970
Quality of skills	122	4.02	.643
Quality of knowledge	120	3.88	.881
Quality of graduates	120	3.73	.995
Resources	120	3.89	.848
Adequacy of training materials	120	3.61	1.079
Infrastructure development	120	3.93	.909
Human resource development	120	3.79	1.003
Availability of teaching materials	120	3.25	1.204
Workshop tools & equipment	116	3.66	.961
Enrolment	118	3.77	.861
Students Enrolment	122	3.86	.816
Retention rates	122	3.78	.828
Completion rates	122	3.96	.648
Efficiency	118	4.01	.722
Efficiency of training process	120	3.78	.822
Acquisition of practical skills	122	3.80	1.018
Utilization of resources	121	3.83	.886

The results in Table 4.5 reveal four indicators of performance in technical institutions with a mean of above 4.00. Quality (mean score=4.22, SD=0.657), quality of skills (mean score=4.02, SD=0.643), quality of infrastructure (mean score=4.01, SD=0.888) and efficiency (mean score=4.01, SD=0.722) were rated most important dimensions of performance in the technical training institutions. Availability of teaching materials (mean score=3.25, SD=1.204) was rated least among the various indicators of performance in the technical training institutions.

### **Regression Analysis and Hypotheses Testing**

The hypothesis of the study sought to establish the effect of the organizational direction on the performance of technical training institutions. Simple regression analysis was done to establish the effects of the strategic direction on performance. Information on this analysis is

presented in Table 4.6.

**Table 4.6 Regression Analysis on Strategic Direction and Performance**

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.694	.495		3.418	.001
Organizational Direction	.516	.121	.359	4.247	.000
R square=12.9%		F-Statistic=18.041(0.000<0.05)			

Table 4.6 shows the relationship between organizational direction and performance. This implies that 12.9% of the variation in performance can be accounted for by organizational direction in the model. Also the F-statistics of 18.04 (p-value 0.00<0.05) indicating that the overall model was statistically significant at 95% confidence level. The relationship between the organizational direction and performance was statistically significant (t=4.247, p-value 0.00< 0.05). This implies that for one unit increase in organizational direction, performance will increase by a factor of 0.516. The hypothesis that there was no significant relationship between organizational direction and performance was not supported in the current study. The predictive regression model can be stated as:

$$Y = 1.694 + 0.516X_1$$

Where Y – Performance

X<sub>1</sub> – Organizational Direction

1.694 – Constant

0.516 – Is the estimate of the expected change in performance when organizational direction is increased by one unit.

These results are in harmony with the findings that strategic direction has an impact on the performance of organizations. Bart *et al.* (2001) study found that mission statements can affect financial performance, partially. The study also observed that commitment to the mission and the degree to which an organization aligns its internal structure, policies and procedures with its mission were both found to be positively associated with “employee behavior”. Bart (1999) in another study of 103 Canadian Hospitals found a strong connection

between mission content and degree of satisfaction with the mission as well as between mission content and degree of satisfaction with financial performance. However, Bart and Baetz (1998) in a study from a sample of 136 large organizations in Canada found out that that mission statements and some of their specific characteristics are selectively associated with higher levels of organizational performance. According to Ireland and Hitt (1992) mission statements provide critical direction for all types of organizations. Developing effective organizational direction can contribute to increases in a firm's overall performance.

### **Moderating Effect of the Relationship between Organizational Direction and Performance**

The researcher sought to establish the impact of the various dimensions of the strategic plan on performance in the presence of the government policy which was considered to be a moderating variable in this study. The results on impact of the organizational direction with the moderator variable are presented in Table 4.7.

**Table 4.7 Regression result of the Organizational Direction with government policy**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error			
1 (Constant)	1.764	.504		3.500	.001
Organizational Direction	.497	.124	.344	4.016	.000
2 (Constant)	1.503	.465		3.234	.002
Organizational Direction	.242	.125	.168	1.939	.055
Government Policy	.331	.068	.423	4.893	.000
1 R squared =0.118	F-statistic=16.125(P-value=0.000)				
2 R squared =0.266	F-statistic=21.574(P-value=0.000)				

As shown by the moderation results in Table 4.7, there is statistically significant change in the percentage of the variation explained by the interaction of the organizational direction and the government policy. The results indicates a change in  $R^2$  when interaction of organizational direction and government policy is introduced ( $r = 0.118$  and  $0.226$ ). The significance results indicates a significant variation in relationship between organizational direction and performance on the introduction of government policy  $0.242, 0.331$ ;  $p$ -value =  $0.055, 0.000$ . Although organizational direction influences performance the presence of government policy improves the relationship significantly. Based on these results performance can be predicted

as follows:

$$Y = 1.503 + 0.242X_1 + 0.331M$$

Where Y = performance of technical training institutions

X<sub>1</sub> = Organizational direction

M= Government policy

This implies that 0.331 is an estimate of the expected increase in the performance of technical training institutions corresponding to an increase in government policy.

### **Conclusions**

Judging from the findings resulting from the data collected from this study, the results reveal some vital facts upon which the conclusions are based. One of the things we can deduce from this study is that strategic direction has significant influences on organizational performance of Technical Training Institutions in Meru County. Organizational objectives dimension of the strategic plan had the highest mean score whereas two dimensions compared to the philosophy and priorities of the organizations captured on the strategic plans.

The introduction of the government policy has a moderator variable in the relationship between strategic direction and performance results in a significant increase in the performance of Technical Training Institutions.

### **Recommendation**

Based on the findings of the current study, the researcher made the recommendations that there is need for the institutional managers to align the institutional philosophy and the priorities to the institutional strategic plans.

The Technical Training Institutions should enhance the competencies of the members of management through training. Training could a good method to equip members with knowledge and skills in strategic planning.

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Yabs, J. (2007). *Strategic Management Practices in Kenya*. 1st ed. Nairobi: Lelax Global ltd,

## **Family Size and boy-Child Drop out Rate in Public Day Secondary Schools in Makueni County, Kenya**

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### **ABSTRACT**

School dropout for both boys and girls is an area of concern not only in Kenya but also in the whole world. The government of Kenya has placed certain measures to give basic education to its citizens by introducing Free Primary Education and Free Day Secondary Education. Despite this effort, students both boys and girls have been dropping out of school. The main purpose for the study was to investigate the influence of family size on boy-child dropout in public day secondary schools in Makueni County, Kenya. The study adopted descriptive survey research design. The target population comprised of all 11 day secondary schools in Kilungu Sub-County, Makueni County. Simple random sampling technique was used to select a sample size of 6 public day secondary schools out of 11; 6 principals and 6 class teachers while 300 boys were selected making a total of 318 respondents. Data was collected using questionnaires, interviews and document analysis. The collected data was analyzed using both descriptive and inferential statistics using the Statistical Package for Social Sciences (SPSS). The findings of the study were that family size influences boy-child drop out from public day secondary schools ( $r = +0.512$ ). From the findings of this study the researchers recommended that the parents should be sensitized on the importance of boy-child education and that the government should provide funds to support boys-child education from poor families.

Key words: Family size, boy-child dropout, day secondary schools.

### **Introduction**

Education has been cited by economic experts as the corner stone for all economic and social

stability within any country. Furthermore education has the power to alleviate poverty all over the world through developing people's skills that increase personal income and therefore the best way to attain self reliance in economic growth and development (World Bank, 2004). Education for All (EFA) is a global commitment that strives to ensure that all children have access to education. The Universal Declaration of Human Rights adopted in 1948 declares that every child has a right to education. The world conference on Education for All (EFA) held in Jomtien, Thailand in 1990 sparked off a new motivation towards education for all.

Kamanja (2012), argues that the boy-child of the 21<sup>st</sup> Century is faced with many problems which unless properly addressed will result in the society losing him. In America, educational systems are losing half of the students through school dropout. A recent study by the US Department of Education found that 3% of American students were dropping out or failing to graduate in the nation's largest public district schools (Education Alliance, 2012). School dropout especially for boys is widely recognized as a negative event followed by various life problems. Although there has been progress in improving school participation since 1990 after the world conference on EFA in Jomtien, there are still high rates of drop out especially for boys which may be as a result of various socio-economic factors in many African countries (Smith, 2011). According to Kanen (2004), the problem of boy-child drop out globally has been on the rise. He pointed out that both high and low social classes of people are affected by the drop out of boys from school. According to his study, 30 % of students in United States leave school before completing the intended education cycle. A research carried out by Siddhu (2011) found that India has boy-child dropout rate of 12% while Asia has a dropout rate of 5%. In Kenya, education has been declared as a basic need to all children and is a legal requirement that each child should attend school and any person who fails to take his/her child to school will have committed an offence and can be taken to court (Basic Education Act, 2013).

Archambault, Janosz, Fallu, & Pagani (2009), observe that causes of boy-child wastage vary from one country to another. A report appearing in The Standard Newspaper, November 8<sup>th</sup> 2013 showed that the dropout rate of girls in Kenya is 2% while that of boys is 2.1%. Another report in Standard Newspaper of 29<sup>th</sup> May 2014 indicated that the dropout rates in 23 sampled counties stood at 3.3% among boys compared to 2.5% for girls. A child's dropout rate means that the resources used for providing education for that particular child are wasted because the child has not acquired the necessary skills, knowledge and attitudes to effectively

participate in the total development of the nation (Parr, 2013). Wastage due to dropping out from school has caused concern to many governments, and other education stakeholders.

According to Mutwol (2013), overall wastage rates in Kenya ranges from 30% - 40 %. This is very discouraging because the government uses a huge amount of public expenditure on education. According to 2011 Economic Survey report, the Ministry of Education, Science and Technology (MoEST) takes the lion's share of the budget. For example, in the financial year 2002 – 2003 the ministry was allocated 64.1 Billion shillings, with this figure rising to 193.3 billion shillings in the financial year 2010 – 2011 (Mudemb, 2013). Findings from the Ministry of Education Science and Technology reveal that not all the students who enroll in secondary schools finish with their education cycle (MoEST, 2007). It is thus clear that some students drop out due to varying individual reasons. Moreover, despite the Constituency Development Fund (CDF) disbursement and bursary allocations to the needy students in Kenyan schools, boys in public day secondary schools have continued to drop out and thus a cause for alarm.

Over the years the boy-child has become vulnerable and endangered as far as education is concerned (World Bank, 2004). A report from the District Education Officer (DEO) Kilungu sub-county education office on enrolment and dropout (2013) indicated that more boys than girls are dropping out of school, a matter of concern for this study. The report shows that between 2010 and 2013, there has been a consistently high dropout rate among boys from public day secondary schools within Kilungu sub-county. For example in the year 2010 there were 1,489 boys at the beginning of the year and 1,480 at the end of the year showing a drop out of nine boys in the sub-county. While in 2011 the number of boys in the sub-county at the beginning of the year were 1,479 and 1,469 at the close of the year meaning 11 boys had dropped out. In 2012 the number of boys at the start of the year were 1,457 and 1,450 at the end of the year an indication that 7 boys dropped out of school; whereas at the beginning of year 2013 the number of boys were 1,444 and the figure dropped to 1,436 at the end of the year meaning that 8 boys dropped out from school. This trend is an indication that the number of boys in public day secondary schools in Kilungu sub-county is consistently declining and therefore the need to investigate the influence of family size on boy-child drop-out rate in public day secondary schools in Kilungu sub-county, Makueni County.

### **Objective of the Study**

The specific objective of the study was to find out the influence of family size on boy-child

dropout rate in public day secondary schools in Kilungu Sub-County, Makueni County.

### **Research Hypothesis**

HO<sub>1</sub>: There is no relationship between the family size and boy-child dropout rate in public day secondary schools in Kilungu sub-county.

### **Literature Review**

Several factors for school dropout have been identified in previous researches. Saliwanchik-Brown (2009), for example found that family socio-economic factors, family composition, student engagement in school, retention and age all contributed to boy-child drop out. In a study by Pharris-Ciurej, Hirschman and Willhoft (2012), it was found that grade retention is the strongest predictor of boys dropout. In general status attainment and drop out, literature points out three main factors predictive of school success. Foley, Gallipoli, & Green (2009) indicate it is due to parental attainment; Inglis (2009) says it is intelligence while Saliwanchik-Brown (2009) says it is socio-economic status that leads to success in education. Researchers are therefore urged to assess the importance of all these factors and the extent to which they cause dropout of boys from public day secondary schools and thus the motivation for this study to investigate the influence of family size on boy-child dropout in public day secondary schools in Makueni County, Kenya.

In the U.S.A., a White House Secretariat office report of 2010 quoted president Obama announcing that the rate at which boys were dropping out of school was a question of concern to all the stakeholders in the education sector. He argued that the Americans could not ignore the big problem of the boy-child dropping out of school. He therefore called on all the stakeholders: parents, guardians, teachers, school principals, students, business leaders and elected officials to join hands and end the boy-child dropout crisis in America. In addition, he noted that for every school day, about seventy school children decide to drop out of school and a total of 1.2 million dropped out in America without attaining the required grade. To address this problem, President Obama proposed four reform models which included the transfer of the principal and the staff, closing and re-opening of schools; and reviewing the managerial skills applied in the affected schools. The Obama administration therefore

committed itself to curb this problem by emphasizing on the importance of investing in dropout prevention and recovery strategies, and to help make learning more engaging and relevant for learners. He therefore committed \$ 3.5 Million and \$50 Million in transformational changes and prevention strategies respectively.

Countries in Sub-Saharan Africa have been struggling to finding out ways of improving their educational systems in order to achieve the Education for All goals (E.F.A.). These countries have laid strategies to meet the set goals by 2015. These strategies include offering free primary education (FPE), providing lunch and snacks in marginalized areas and monitoring whether the children attend school regularly. This has motivated children from poor families to go to school (Wang & Fredricks, 2013). This effort eventually has attracted the attention of the donors from various parts of the world especially in the developed countries, which include World Education Forum, UNICEF and WHO (World Bank, 2004). The most affected are boys from poor families and orphans (Cameron, 2009), hence the concern on boy-child drop out from public day secondary schools in Makueni County.

School dropout has become a major educational problem in developing countries. It has been noticed that there has been a high enrollment and low completion cycle especially for boys in public day secondary schools (Oteyo & Kariuki, 2009). Dropout rates depend on the number of children enrolled and so in countries where there is low initial enrolment, actual number of students who drop may be lower than where initial enrolment is high (Joshi, 2010). In Malawi, dropout rates are still high though free primary education was started earlier than in any other African country (Siddhu, 2011). High enrolment in Malawi led to poor education because there weren't enough teachers to handle the students and therefore temporal teachers were employed to curb this problem. This made many students especially boys, lose interest in school hence dropping out. The main reason of boy-child drop out in Malawi is lack of interest in learning and lack of role models among family members (Smith, 2011).

Having a big family may lead to boys drop out of school especially if the family income is low. Symeou, Martinez and Alvarez (2012) say that many children especially boys from big sized families dropout of school to work for income to support their families. This comes as a result of parents being unable to provide basic needs to their children and hence force the older sons to drop, search for casual jobs and help them (parents) bring up their children in the big family. Once the boys get these casual jobs which they can do after school, they feel

that they have become adults and therefore drop out completely from secondary schools (Oteyo & Kariuki, 2009). This will therefore lead boys' to dropout so that they can help their parents in providing for their siblings. If getting food is a problem, then it would not be possible to cater for education of the children, especially boys because it is more expensive (Mudemb, 2013). Boys from big families may be encouraged by their parents to drop out of school to go and work to supplement the family income and make it easier for the parents to take care of the young siblings (Symeou *et al.*, 2012). Research done by the Ministry of Education (MoE) in 2006 showed that as boys grow older their needs increase and if they come from a big family their parents may not be able to provide for their needs and therefore they might drop out of school to search for casual jobs so as to cater for their own needs. Most boys in Kilungu Sub-County may be dropping out of school to indulge in casual work like sand harvesting, loading and unloading the sand Lorries. Sand is being harvested in big rivers around the sub-county like Kaiti River and the sand is taken to construction sites around the county headquarters. This study set out to establish how family size influences boy-child dropout from public day secondary schools in Makueni County.

In Kenya, the dropout of boys in public day secondary schools draws back the achievement of Vision 2030 which was set by the Kenyan government to industrialize the nation and to improve education and training for all (Vision, 2030). This leads to wastage of potential human resources necessary for development (Business Daily, 2013). The initiation of free primary education by the government in 2003 and free day secondary school education in 2008 resulted into increased school enrolment but boys are still dropping out of school due to factors like poverty, insecurity, lack of basic needs and natural catastrophes (Symeou, Martínez-González, & Álvarez-Blanco, 2012). Dropout of boys in Kenyan public day schools has been on the higher side in spite of the government's effort to attain universal education by introducing free public day secondary education (Oteyo & Kariuki, 2009).

The government of Kenya spends a lot of money on free day secondary education. According to Mutwol (2013) the economic survey of Kenya indicates that MOEST takes the lion's share of the national budget. This is to support free primary education and free day secondary education. Expenditure on education accounts for a significant portion of the county's resources. For example in Kenya 2012-2013 year's budget, education sector was allocated 233.1 billion which is 16% of the total budget of 1,459.9 billion. Among the allocations 8.3 billion went to free primary education, 19.7 billion went to free day secondary education, 1.6

billion went to early child development education, 118.7 billion went to teachers' salaries and 84.8 billion went to other projects including research (Ramsey, 2012). Failure to address issues affecting boy-child school dropout will mean that government resources are wasted and therefore the need for this study.

## Methodology

The target population for the study was 11 Day secondary schools, 11 principals from these schools, 25 class teachers (Form 3 & 4) and 550 boys (Form 3 & 4) in Kilungu Sub-county, Makueni County. The 6 principals in the sampled schools were selected to participate in the study. Given that some schools have more than one stream, simple random sampling was used to select 12 out of 25 class teachers and 300 boys from the selected schools. The sample size was 318 respondents including school principals, class teachers and students as shown in Table 1.

**Table 1: Sampling Frame Table**

<b>Respondents</b>	<b>Target Population</b>	<b>Sample Size</b>	<b>Percentage</b>
Principals	11	6	54.54
Class Teachers	25	12	48.00
Boys	550	300	54.54
<b>Total</b>	<b>586</b>	<b>318</b>	<b>54.26</b>

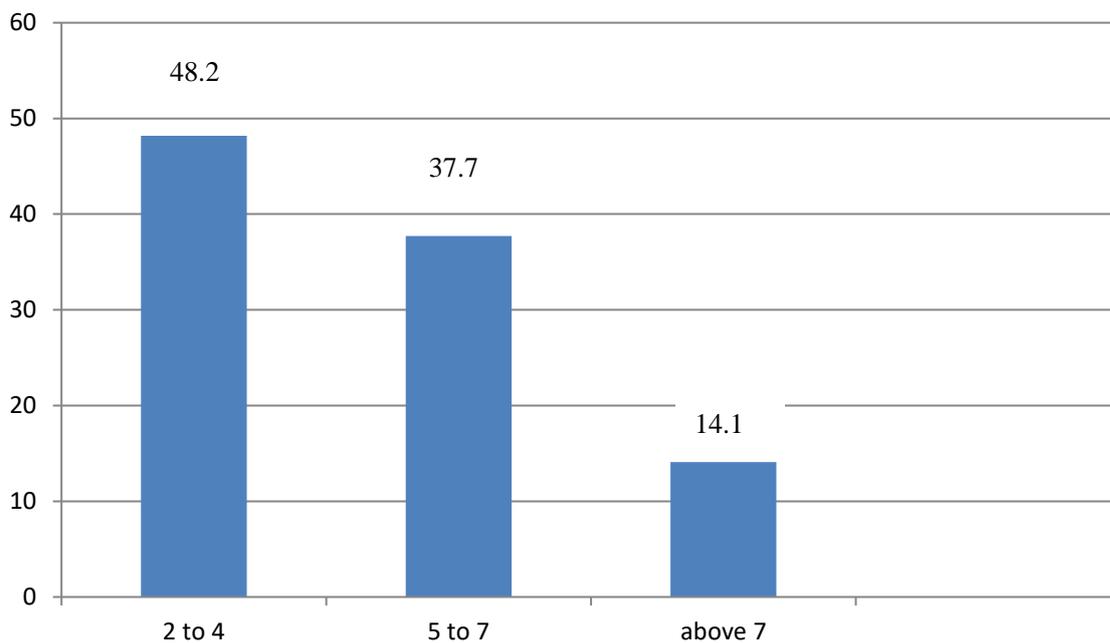
Data was collected using questionnaires, document analysis and interviews. There were two different sets of questionnaires for class teachers and students (Form 3 & 4 boys). Document analysis was based on records obtained from the principals' offices in the selected schools. These documents included class registers and admission records for the years 2010, 2011, 2012 and 2013. The main purpose of examining these records was to establish the trend of boys' enrollment in Form one, retention rate in the school and dropout rate in the school in these years. The information gathered was basically made to supplement data collected using the questionnaires for teachers and students, and interviews with school principals.

The data collected from the field was coded and processed by computer using the Statistical Package for Social Sciences (SPSS). Data was analyzed using both descriptive and inferential statistics. Analyzed data was presented in the form of frequency distribution tables and percentages which were in line with the questionnaires. The null hypothesis was tested using

Pearson's Product Moment Correlation Coefficient.

### Results and discussion

The main objective of this study was to find out the influence of family size on boy-child drop out from public day secondary schools in Kilungu sub-county, Makueni County. To achieve this objective the researcher investigated the number of members in a family. The respondents were required to indicate the number of family members. The results are presented in figure 1.



**Figure 1: Family members (%) in a family**

The main objective for this study was to find out the influence of family size on boy-child dropout from public day secondary schools in Kilungu Sub-county, Makueni County. The study revealed that most of the families, 100 (48.2%) had between 2 – 4 children, followed by 79 (37.7%) with 5-7 children, while 29 (14.1%) had more than 7 children. However, the principals through an interview indicated that the average number of children as given by the parents was 5 children per family. This implies that most families in Kilungu sub-county have 5 children per family which is relatively a big number. This finding concurs with those of Symeou, Martinez & Alvarez (2012) who argue that many children especially boys from big families drop out of school to work for income to support their big families. From the findings, boy-children who come from big families do not complete secondary education

because it may be hard to pay the fees. This goes hand in hand with the findings of Mudemb (2013) who argued; that it may be hard to educate children in big families because if getting food is a problem, then it cannot be possible to cater for education which is more expensive.

It was also found that it was also established that 102.5 (49%) of the respondents strongly agreed with the statements: boys from families with 2-4 children drop out of school, boys from families of 5 and above children do not complete Form 4 while parents with 7 children and above do not pay fees for their sons as shown in Table 2.

**Table 2: Family Size and Dropout**

STATEMENTS	SA	A	U	D	SD	Total
Boys from families of 2-4 children drop out of school	100 (48%)	50 (24%)	5 (2.4%)	30 (15%)	23 (11%)	208 (100%)
Boys from families with 5 children and above members do not complete Form 4	140 (67%)	20 (10%)	0 (0%)	30 (15%)	18 (8%)	208 (100%)
Parents with 7 children and above do not pay school fees for their sons	120 (58%)	40 (19%)	0 (0%)	48 (23%)	0 (0%)	208 (100%)
There is likelihood of boys who have all their basic needs met drop out of school before completing Form 4	50 (24%)	50 (24%)	0 (0%)	18 (8%)	90 (44%)	208 (100%)
Mean Response	102.5 (49%)	40 (19.4%)	1.25 (0.6%)	31.5 (15%)	32.7 (16%)	208 (100%)

Table 2 indicates that majority of the respondents, mean 102.5 (49%) strongly agreed with the statements given, 40 (19.4%) agreed, 1.25 (0.6%) undecided, 31.5 (15%) disagreed and 32.7 (16 %) strongly disagreed respectively.

The null hypothesis was tested to establish whether there is a significant relationship between family size and boy-child dropout. The null hypothesis stated that; there is no significant relationship between family size and boy-child drop out. The relationship in the variables;

family size and boy-child drop out showed that there is significant relationship between family size and boy-child drop out and thus the null hypothesis was rejected. The results are presented in Table 3.

**Table 3: Relationship between Family Size and Boy-child Drop Out**

		Family Size	Boy-child drop out
Family Size	Pearson's correlation	1	0.512
	Sig(2 tailed)		0.0023
	N	208	208
Boy-child drop out	Pearson's correlation	0.5120	1
	Sig(2 tailed)	0.0023	
	N	208	208

Correlation significance value = 0.05

Table 3 shows that the correlation coefficient between family size and boy-child drop out is  $r = +0.512$ , implying that there is a strong positive correlation between family size and boy-child drop out. Big family or small family therefore may influence boy-child drop out from public day secondary schools in Makueni Sub-County. The the null hypothesis was thus rejected that because there is a positive relationship between the variables; family size and boy-child drop out from public day schools in Kilungu sub-county. A big family therefore influences dropout of boy-child from public day secondary school and this concurs with Symeou et al (2012) who stated that, having a big family size may lead to boys drop out of school especially if the family income is low.

From the findings therefore, it was concluded that boys from day public secondary schools in Kilungu sub-county, Makueni County dropped out of school, especially those from big families, due to inadequate resources for the large number of children in a family. The study recommends that parents should be encouraged to come up with new strategies of increasing their earnings so as to increase their income and be able to pay fees for their sons. This can be communicated during parents meetings in the school. The parents should also be made aware of the importance of boy-child education at the County level. The government and private agencies should intervene and provide more funds in the schools as bursaries so as to help boys from low income families finish their education.

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## **Sub-Theme: Business and Innovative Approaches for Small & Medium Enterprise Development**

**Family Business Succession Planning, Entrepreneurial  
Orientation and Firm Performance among Small and Medium Enterprises**

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### **ABSTRACT**

Family-owned businesses continue to form the backbone of most of the national economies. However, because of the tenuous nature of the ownership structure of most family businesses only one in three family businesses succeeds in making it to the second generation. These smaller businesses are particularly vulnerable to the impact of unexpected, life-altering events that affect the business owner and often the business itself, therefore need to consider proper succession of the businesses. The paper therefore seeks to review literature on the relationship between planning, family business succession entrepreneurial orientation and firm performance of small and medium enterprises. The review also gives the back ground of the study on family business and their role in economic development ,having successful succession planning in mind. The aim is to shed some light on what other scholars have written about the role of family business succession planning and entrepreneurial orientation

on firm performance. The paper also looks at the theoretical foundation of entrepreneurship that gives a firm foundation of study.

Keywords: Family business Succession planning, Entrepreneurial Orientation and firm performance.

## **1.0 Introduction**

### **1.1 BACKGROUND OF THE STUDY**

Internationally, the overwhelming majority of family businesses are small or medium-sized, it is estimated that the proportion of all worldwide business enterprises owned or managed by families at between 65% and 90% (Sharma, Chrisman and Chua, 2000). Another report by (UNIDO, 1999) estimates that SMEs represent over 90% of private business and contribute to more than 50% of employment and of GDP in most African countries (Al Masah, 2011). In Ghana, SMEs represent about 92% of businesses and contribute about 70% to Ghana's GDP and over 80% to employment. SMEs also account for about 91% of the formal business entities in South Africa, contributing between 52% and 57% of GDP and providing about 61% of employment (Ntsika, 1999; Gumede, 2000; Berry *et al.*, 2002). Only 10 % of the Family businesses survive up to the third generation this is attributed to many reasons key being lack of succession planning

Study of family businesses is relatively new, because of this novelty there has been several debates on definitions, the scope, the characteristics and the relationships between SP and firm performance (Colli, 2003). We tend to believe that the public side of the corporate world defines our global economy contrary to this when we explore further, a subset of the business world, a more private, low profile side turns out to be the main driver, the Family businesses. SMEs are universally acknowledged as effective instruments for employment generation and economic growth. In developing countries, they play a critical role in stimulating economic growth and wealth creation (Maalu, 2010). SMEs in Kenya employed 3.2 million people in 2003 and this accounted for 18% of national GDP.

Entrepreneurship is always linked with performance and succession planning.. The main focus of this paper is therefore the role played by Succession planning and entrepreneurial orientation to achieve firm's performance.

### **1.2 FAMILY BUSINESSES**

There are quite distinct definitions of family business, Wortman (1995) contends that more than 20 definitions are in use and researchers usually develop a definition that suits their

needs. Handler (1989) notes a lack of definition consensus. Most definitions focus on family ownership, family involvement family control and or the intention to transfer the family firm. Donnelly (1964) suggests that a family firm is one which has closely identified at least two generations of a family and company policy and family interests are related. The husband-wife business is largely different from a large family company considering the participation of family members in ownership and day-to-day management. Gersick et al. (1997) propose a three-dimensional view of the family firm taking account of the position of a company in terms of family, ownership and business life-cycles. Litz (1995) has categorised family firms in three groups considering ownership and management, avoiding a static perspective, since successful family firms usually develop into larger firms with non-family ownership but with family managers involved in day-to-day management or even going public but with family members still in senior management positions.

The difficulty with the definition of a family firm is compounded with the finding that family-business relationship changes according to the structure and size of the business (Fletcher, 2000). A few business surveys associate family business with SMEs and emphasize the issue of family ownership. GEM UK Family Business Adult Population Survey (GEM, 2006) the criteria used is where a family or individual owns more than a 50 % controlling stake in the business, it could be a micro business, SME, large company, partnership or publicly quoted. There has been more effort to differentiate between different types of family firms. (Westhead et al, 2002) useful typology of family firms where a company has undergone an inter-generational transition, where 50 % of ordinary voting shares owned by a family group related by blood or marriage.

### **1.3 FAMILY BUSINESS SUCCESSION PLANNING**

Succession planning may be broadly defined as a process for identifying and developing potential future leaders or senior managers, as well as individuals to fill other business-critical positions, either in the short- or the long-term. It requires tailored work experience that will be relevant for future senior or key roles. Researchers show that only a small percentage of family firms survive the transition to the second generation and many intergenerational transitions fail soon after the second generation takes control (Davis & Stern, 1998; Handler, 1989)

The main reason for the failure being economic and financial issues and others caused by the inability of the firm to overcome the loss of key contributors (Lussier & Sonfield, 2004), hence the importance of succession planning. Thus, is it not surprising that management succession is the most important concern of family business leaders (Chua, Chrisman,

&Sharma, 2003), the issue for which family business consultants are most frequently engaged.

#### **1.4 ENTREPRENEURIAL ORIENTATION**

Entrepreneurship is the dynamic process of wealth creation. Individuals create wealth by taking major risks such as time; financial and social and/or career they commit to provide value for some product or service Ronning (2006). The product or service may be old or new or unique, value creation is infused by the entrepreneur by receiving and allocating the necessary skills and resources. Entrepreneurial activity represents one of the key engines of economic growth and today accounts for the majority of new business development and job creation in the world.

Innovation is at the heart of entrepreneurship Drucker (1985), it helps in coping with rapidly changing environmental condition. Innovation could be in the form of new products, services, and processes, or in a combination of these (Schumpeter, 1934) The role of innovation in driving growth has been recognized by governments, business and academia. The high death rate of start-up and small firms has been attributed to their newness and size (Maaluan McCormick, 2011), the enterprises are forced to make innovations and be more proactive so as to survive.

A study of innovation in Ghanaian SMEs found that entrepreneurs have introduced innovations in a range of products, services, production processes, work practices, and marketing that have brought benefits to their firms (Robson et al. 1994). Researchers such as (Covin & Slevin, 1991) Have argued that entrepreneurship is an essential feature of high-performing firms.

#### **1.5 FIRM PERFORMANCE**

Firm performance measures are defined as metrics employed to measure the efficiency and effectiveness of actions, but remain an issue for debate in business research. A diverse range of measures used constitutes on additional sources of methodological heterogeneity (Venkatraman and Ramanujam, 1986). There has been no generally accepted definition of performance; this has complicated the gauge to be used as a measure of performance. It is important to control variables such as firm age and size, otherwise a firm performance can be considered ambiguous. The most common financial measures include Profit margin or ROS which determine a firm's ability to withstand competition, adverse rising costs, falling prices, and future declining sales. The other measure is ROA which is the ability to utilize assets. Finally we have ROE which is payment of dividends to stockholders.

There are other non quantitative measures of performance such as s customer and employee

satisfaction, they complement the hard measurement practice. Customer-based measures are becoming more popular because of an endeavor by firm to offer quality customer improvements, which ultimately lead to company profits. Other measure includes customer complaints surveys (Stone & Banks, 1997). For small firms however their main purpose is to stay in business, the best measure would then be subjective performance and non-financial measures. The recognition of Family businesses (Timmons, 2007) and the roles they play in wealth creation has encouraged discussions in this area.

## **2.0 LITERATURE REVIEW**

### **2.1 Theoretical foundation of the study**

Entrepreneurship is multidisciplinary by nature, Several theories have been put forward by scholars to explain the field of entrepreneurship. According to researchers the field of entrepreneurship lacks a distinct professional identity, one defined by a unified body of knowledge based on generally accepted social science theories (Bull & Willard 1993). There have been debates and contributions from Entrepreneurial scholars like Cantillon, Schumpeter and Schultz to date regarding this field.

### **2.2 Resource Based Theory of the Firm**

Economist entrepreneurship only takes place where economic conditions are most favorable, although its foundation is high on high order in social, psychological, ethical or patriotic. Entrepreneurial activity deals with forms, the transformation of ideas or raw materials to finished goods that can be consumed. Alvarez and Busenitz (2001) look at the theory as the cognitive ability of individual entrepreneurs, entrepreneurship theory looks at the heterogeneity in beliefs about the value of resources. However the belief about the resource is its value (Alvarez & Busenitz, 2001). There has to be recognition of an opportunity, the ability in terms of human capital to take advantage of it and a market for the final products.

The classical theory extolled the virtues of free trade, specialization, and competition (Ricardo, 1817). The theory was the result of Britain's industrial revolution which took place in the mid 1700 and lasted until the 1830s. The classical movement described the directing role of the entrepreneur in the context of production and distribution of goods in a competitive marketplace (Say, 1803). Classical theorists articulated three modes of production: land; capital; and labor.

The neo-classical model emerged from the criticisms of the classical model and indicated that economic phenomena could be relegated to instances of pure exchange, reflect an optimal ratio, and transpire in an economic system that was basically closed.

### 2.3 Psychological Theories

Psychological factors are an important consideration in planning for succession in family Business, Sharma, Chrisman, and Chua, (2003). These theories emphasize personal characteristics that define entrepreneurship. Personality traits, need for achievement and locus of control are the personal characteristics key to Entrepreneurial Orientation. Other characteristics that have been found to be associated with entrepreneurial inclination are risk taking, innovativeness, and tolerance for ambiguity.

Personality traits are stable qualities that a person shows in most situations, to the trait theorists there are enduring inborn qualities or potentials of the individual that naturally make him an entrepreneur Coon (2004). However, the theory gives some insight into these traits or inborn qualities by identifying the characteristics associated with the entrepreneur. Some of the characteristics or behaviors associated with entrepreneurs are that they tend to be more opportunity driven, demonstrate high level of creativity and innovation, and show high-level of management skills and business know-how. They have also been found to be optimistic, , emotionally resilient and have mental energy. They also believe that they can personally make a difference, are individuals of integrity and above all visionary.

While the trait model focuses on enduring inborn qualities and locus of control on the individual's perceptions about the rewards and punishments in his or her life, need for achievement theory by McClelland (1961) explained that human beings have a need to succeed, accomplish, excel or achieve. Entrepreneurs are driven by this need to achieve and excel. While there is no research evidence to support personality traits, there is evidence for the relationship between achievement motivation and Entrepreneurship. Achievement motivation may be the only convincing person logical factor related to new venture creation (Shaver & Scott, 1991).

### 2.4 Social Network Theory

Entrepreneurs are embedded in a larger social network structure that constitutes a significant proportion of their opportunity structure (Clausen, 2006). An individual may have the ability to recognize that a given entrepreneurial opportunity exist, but might lack the social connections to transform the opportunity into a business start up. It is thought that access to a larger social network might help overcome this problem in a similar vein, Reynolds (1991) mentioned social network in his four stages in the sociological theory.

The literature on this theory shows that stronger social ties to resource providers facilitate the acquisition of resources and enhance the probability of opportunity. Other researchers have

suggested that it is important for nascent founders to have access to entrepreneurs in their social network, as the competence these people have represents a kind of cultural capital that nascent ventures can draw upon in order to detect opportunities (Gartner et al, 2004).

## **2.5 ENTREPRENEURIAL ORIENTATION**

Entrepreneurial Orientation is an economic process of creative destruction by which wealth is created. when existing market structures is disrupted by the introduction of new goods or services, new combination, new ideas, new technology that shifted resources away from existing firms and caused new firms to grow. Innovations vary in their degree of radicalness (Hage, 1980), it represents a basic willingness to depart from existing technologies or practices and venture beyond the current state of the art. There are numerous methods by which to classify innovation but perhaps the most useful distinction is between product-market innovation and technological innovation.

There has been focus on technological innovativeness, which consists primarily of product and process development, research, and an emphasis on technical expertise and industry knowledge. Product-market innovativeness suggests an emphasis on product design, market research, and advertising and promotion (Miller & Friesen, 1983). Subsequent researchers have endeavored to capture additional aspect of innovativeness, for example, Zahra and Covin (1995), who focused on technology policy. This is firms commitment to acquiring, developing, and deploying technology. Innovativeness is an important component of family business, it reflects an important means by which firms pursue new opportunities for survival and growth.

Risk is uncertainty of venturing into the unknown, committing a relatively large portion of assets, and borrowing heavily. In entrepreneurship literature there are uncertainties such as personal risk, financial risks, social risk, or psychological risk. In broad sense risk is probability of a loss or negative outcome (Miller and Friesen, 1978). The early entrepreneurship literature equated the idea of entrepreneurship with working for oneself, seeking self-employment rather than working for someone else for wages, in this case assuming personal risk (Shane, 1994b). Entrepreneurial and non-entrepreneurial behaviors are clearly distinguished with the risk taking features of the individuals and organizations. In this sense business risk taking is conceptualized as the organizational orientations to go for new initiatives for the purpose of family business profit and growth by tolerating the possible calculated loses.

The term Proactiveness is acting in anticipation of future problems, needs, or changes. As such, Proactiveness may be crucial to an entrepreneurial orientation because it suggests a

forward-looking perspective that is accompanied by innovative or new-venturing activity. Entrepreneurial managers are important to the growth of firms, this provides the direction and imagination necessary to engage in opportunistic expansion, Penrose (1959). First-mover is the best strategy for capitalizing on a market opportunity. By exploiting advantages in the market-place, the first mover can capture unusually high profits and get a head start on establishing brand recognition, this has become very common with entrepreneurs. In an early formulation is the Proactiveness of a firm's decisions to determine on the survival of the business introducing new products, technologies, administrative techniques.

## **2.6 FAMILY BUSINESS INSTITUTIONS**

Institutional theory is traditionally how various groups and organizations better secure their positions and legitimacy by conforming to the rules and norms of the institutional environment (Meyer & Rowan, 1991; Scott, 2007). The term institution broadly refers to the formal rule sets (North, 1990), less formal shared interaction sequences and taken-for-granted assumptions (Meyer & Rowan, 1997) that organizations and individuals are expected to follow. These are derived from rules such as regulatory structures, governmental agencies, laws, courts, professions, and scripts and other societal and cultural practices that exert conformance pressures (DiMaggio & Powell, 1997). These institutions create expectations that determine appropriate actions for organizations (Meyer & Rowan, 1997), and also form the logic by which laws, rules, and taken-for-granted behavioral expectations appear natural and abiding. Institutions define therefore what is appropriate in an objective sense, and thus render other actions unacceptable or even beyond consideration (DiMaggio & Powell, 1991). The cognitive pillar summarized by Scott (2007) and derived heavily from the recent cognitive turn in social science (DiMaggio & Powell, 1983) represents models of individual behavior based on subjectively and constructed rules and meanings that limit appropriate beliefs and actions. The cognitive pillar may operate more at the individual level in terms of culture and language (Carroll, 1964 and Scott, 2007), and other take no seriously taken behavior that people barely think about (DiMaggio & Powell; Meyer & Rowan, 1991). This pillar is increasingly important to entrepreneurship research in terms of how societies accept entrepreneurs, inculcate values, and even create cultural beliefs whereby entrepreneurship is accepted and encouraged.

## **2.7 FAMILY BUSINESS SUCCESSION**

Succession planning is a contingency plan an organization develops to address the eventual loss of key human resources. More specifically, it is the process of developing key people through a process that identifies candidates and tracks their progress and development

(Nardoni, 1997). Succession planning has gained wider acceptance in the corporate world. Studies conducted show 67% of those surveyed reported that succession planning had grown in importance in the last decade (Howard & Associates, 2003). The emergence of succession planning in larger firms can be credited to the teamwork and bureaucracy needed to run a large organization. In addition, the corporate boards of large organizations have forced senior management to consider succession planning (Howard & Associates, 2003). One poll of executives found 100% of those surveyed believed it useful to identify and groom a successor. However, the same study found that only 72% were actually grooming people for these key roles (Messmer, 2002).

No matter how successful, every small business will, at some point, experience the loss of key contributors. Oftentimes, these losses are in the form of an owner or founder whose vision helped build and sustain the culture. In fact, given that half of all U.S. small business owners are aged 60 or older (Fleming, 1997), it appears that planning for the eventual turning over of the reigns is more important than ever. For most family and closely held businesses, planning for succession is the toughest and most critical challenge they face. Yet succession planning can also be a great opportunity to maximize opportunities and create a multi-generational institution that embodies the founder's mission and values long after he is gone. A low-level job entry strategy in the FOB facilitates the establishment of strong relationships with key stakeholders. However, a major disadvantage associated with this entry strategy is that mistakes may be too readily viewed as a sign of incompetence on the part of the successor. While the delayed entry route allows the successor to build self-confidence and credibility, the main drawback of this strategy is that specific expertise and/or an understanding of the culture of the family business may be lacking once the successor joins the FOB (Fox et al., 1996). Handler (1989) argues that factors such as degree of training, degree of responsibility, and experience outside the organization, communication concerning succession and planning around succession influence succession effectiveness.

## **2.8 FAMILY LEVEL SUCCESSION PROCESS**

The Three Circle Model is generally accepted as the standard model for family businesses and includes family, business and ownership as the three main components (Gersick et al, 1997). The acknowledgment that there are three separate circles is a significant accomplishment for a family business. Too often, the circles are constantly intertwined. This results in poor communication, resentment and a lack of commitment to the future the very things the business family is trying to prevent. Each circle has a governance structure and a plan. A family council would govern the family and prepare a family plan. A management

team would lead the business and prepare a management development plan for succession and a business plan.

The board monitors company performance, advises the chief executive officer and makes decisions regarding dividends and reinvestment of profits. The board oversees succession planning, sets the strategic direction of the business by developing or approving the strategic plan, and develops leadership continuity plans and contingency plans (Gersick et al, 1997). A team of advisors would be required to assist the board in preparing a succession plan. These advisors would include a lawyer, accountant, financial planner, insurance broker, banker, and a succession planning consultant who could lead and coordinate the team on behalf of the business family.

Fostering good communication between all the individuals involved in the succession process emerges as a prime concern during succession planning. Whereas open honest dialogue, where respect for others is maintained, can help foster a rational focus on the most important considerations for achieving a smooth succession (Hamilton, 2003), creating a genuine cross-generational dialogue is crucial as it provides the basis for negotiating the succession planning processes. Preparedness of each individual for the transition will have a major bearing on the outcome of family business successions. (Morris, et al., 1997). The willingness and preparedness of the incumbent to relinquish control and the willingness and preparedness of a successor to assume control are major influences on succession planning. Incumbents are in a powerful position to resist an orderly succession due to personal considerations or choices. This can be despite the needs of the firm, and others, for a sufficiently long and comprehensive process that is able to ensure the acquisition of skills and experience necessary for continued good business performance.

### 3.0 Family Business Performance

#### **3.1 Family Performance**

Performance is an important variable in SMEs and large firms; it is always the concern of the business for Managers and the Business. Besides this academicians (Venkatraman & Ramanujam, 1986) are also keen on the end results of any venture. A diverse range of measures used constitutes an additional source of methodological heterogeneity, a variety of approaches applied to study performance in research settings together with a lack of agreement on basic terminology, make performance measurement complicated. Three most common financial measures include: Profit margin/return on sales, Return on assets and Return on equity. Different authors have combined several factors both qualitative and

quantitative to measure performance in their studies. This is because of difficulties in obtaining quantitative data (Venkatraman & Ramanujam, 1986) particularly for small and medium businesses. Using a combination of several indicators takes care of both operational and financial issues both which both has link to the performance a firm. Frank, Kessler and Fink (2010) combined two measures, sales growth and cash-flow growth relative to competitors to capture performance. They measured both factors using seven-point Likert scales which constitute a reduced version of the measure used by (Wiklund & Shepherd, 2003). Hannan and Freeman (1984) also asserted that firm growth has been associated with the ability to better withstand environmental shocks and is a core element underlying the resource-based view of the firm (Barney, 1991) where theorists propose that resource endowments are the crux of a firm's ability to grow. Thus, firm growth is an important dependent variable in the study of organization.

Softer non-financial issues such as customer and employee satisfaction are complemented by hard measurement practice. Customer-based measures are gaining popularity because of an enthusiasm for customer-led quality improvements, which ultimately lead to company profits. A common measure includes procedures and surveys on customer complaints (Stone & Banks, 1997). Soft measures can also be used to monitor or induce cultural change, improve communications, morale, and team spirit. For small firms however, subjective performance and non-financial measures appear to be more essential than quantitative measures. E.g. cash, rather than the maintenance of a smooth cash flow from profit is an important indicator to owner managers whose objectives are to stay in business.

### 3.2 Family Succession and Firm Performance

Maalu (2010) examined Succession strategy and performance among SMEs in Kenya; he used a cross sectional survey and also case studies in Nairobi. The selected cases were able to provide information which has longitudinal information and can facilitate measurement of changes of variables over time. He found out that succession strategy has a positive relationship with firm performance

Noor, et al, (2010) examined the relationship between family successions attributes and firm performance among Malaysian Companies. This study adopted balanced panel data analysis for 975 companies listed on Bursa Malaysia for the year 2003 to 2007. The findings indicate that some of the family succession attributes do influence firm performance. Family succession was found to be positively related with firm performance. Families are motivated to work efficiently when more shares were in their hands. Furthermore, the results reveal that

successors-managed firms have better firm performance than founder-managed firms.

Another study in Italy, by Cuccuelli and Micucci (2008) on firm performance and succession, focusing on impact of founder Chief Executive officer succession as opposed to management being passed to the outsiders. They further analyzed the by assessing the performance of the firms after the succession in the midst of competition within the sector. They found out that family business that maintained formal management performed poorly at the expense of the best performers that were family managed. This indicated that organizational structures in family businesses did not have any positive impact on performance especially in the middle of competition and so recommended the importance of analyzing the governance within those firms.

In Denmark a study was carried out by Bennedsen et al (2007) on the relationships between the succession and firm performance. They investigated the impact of family characteristics in corporate decision making and the results of these decisions on the firm performance. The focus was on the decision to appoint either external or internal CEO, they also looked at gender of departing CEOs and also first born child. They found that around transition period the firm's performance fell by four per cent. They also found out that the CEOs performance of the firm fell in fast growing large firms that have high skilled labor force.

### 3.3 Entrepreneurial Orientation and Firms Performance

Empirically, most research studies employ the construct of business performance to examine a variety of entrepreneurship content and process issues. Some empirical studies done have expressed concerns about the relationship between entrepreneurial orientation and performance (Dess, Ireland & Hitt, 1997; Lyon, Lumpkin & Dess, 1996; Wiklund & Shepherd, 2003). They suggested that entrepreneurial orientation may affect firm performance; however environment or other organizational factors also play an important role (Dess et al, 1997; Lumpkin & Dess, 1996; Zahra & Covin, 1995). Other researchers have found support for a direct relationship between EO and firm performance (Wiklund, 1999; Lee, Lee & Pennings, 2001).

A study in Malaysia on Entrepreneurial Orientation and Performance by Amran et al (2009) found that EO was significant and has positive relationship with performance. Moderating impact showed significant interaction effect of human capital and information technology munificence on Proactiveness-performance relationship. The finding strongly supported the resource-based view when the main effect of EO and moderating effect of environment showed significant change in the relationship. Innovativeness and risk taking direct impact on

performance supported studies in EO-performance relationship. Moderating impact of human capital and information technology munificence on EO-performance relationship were crucial for proactive firm in achieving superior performance. The study reconfirms that independent effect of each EO dimension on performance contributes more in-depth knowledge in the differential relationship of innovativeness, Proactiveness and risk taking with objective performance.

Fakhrul and Selvamalar, (2011) in their study on entrepreneurial orientation and firm performance, they found out that innovative, risk-taking and proactive has a direct relationship with the firm performance of a firm. Business owners must therefore seriously think about implementing policies and procedures to promote EO to ensure a firm's survival and best performance. The findings of the study disclosed that indigenous Malaysian entrepreneurship differs slightly from the conventional Western concepts of entrepreneurship; this is due to the Malaysian culture. The study also reveals that to develop an entrepreneurship culture on a historically agrarian society is a challenging and demanding task that requires time and relentless efforts. The conclusions reached by this study demonstrate that Malay entrepreneurs are not hindered by Malay entrepreneurial developments but by misconceptions as well as lack of knowledge in financial management.

### 3.4 Emerging Issues in Entrepreneurship

Hundreds of millions of people in developing countries earn their living through small-scale Business (World Bank, 2004; de Soto, 1989). Mead (1998) observes that the health of the economy as a whole has a strong relationship with the health and nature of micro and small enterprise sector. The Small and Micro Enterprises (SMEs) play an important role in country's economy, in Malaysia; this norm is no exception SMIDEC (2008). In order for vision 2020 to be fully developed and become an industrialized nation by the year 2020, the future progress seems to depend greatly upon development of SMEs.

In the year 2020, the country will develop to become an industrialize nation by capitalizing on the country's strengths and able to overcome weaknesses. In response to the drastic changes, SMEs play an important role in developing country to a higher level. According to Schlogl (2004), small and medium-sized firms dominate economies in terms of employment and number of companies, yet their full potential remains remarkably untapped. Although there is a broad assumption stating that SMEs generally has positive effects on country economic growth, the notion of economic imperatives for SMEs remains largely untested.

The increasing demand of the SMEs is the recognized feature of most nations, for example in

Bangladesh the aim of Small and Medium Enterprise Programmes is to support government efforts to foster development of the SME sector by strengthening the policy environment for SMEs and improving SMEs' access to credit and related services. This will enable the sector to attain its full potential for contributing to sustainable economic growth and, through generation of employment, the reduction in poverty. Poverty reduction target is more than 3% per year that was 1.5% during 1990s. Accordingly, Government's priority is to accelerate and expand a sustainable SME sector for pro-poor economic growth and employment generation. The Kenya Economic Survey (2011). Impact Accelerate development of SME sector and enable SMEs to attain their full potential for contributing to sustainable economic growth and Poverty reduction.

Despite their significance, past statistics indicate that three out of five businesses fail within the first few months of operation (Kenya National Bureau of Statistics, 2007). One of the most significant challenges is the negative perception towards SMEs (Amyx, 2005). Potential clients perceive small businesses as lacking the ability to provide quality services and are unable to satisfy more than one critical project simultaneously. Often larger companies are selected and given business for their clout in the industry and name recognition alone. Because of the liability of size and newness of small firms (Maalu, 2010), a simple management mistake is likely to lead to sure death of a small enterprise hence no opportunity to learn from its past mistakes (Bowen, Moraa and Mureithi 2009).

SMEs face challenges such as; competition among themselves and from large firms, lack of access to credit Lack of credit has also been identified as one of the most serious constraints facing SMEs and hindering their development (Oketch, 2000; Tomecko & Dondo, 1992; Kiiru, 1991), cheap imports, insecurity, lack of skills and debt collection. Lack of planning, improper financing and poor management have been posited as the main causes of failure of small enterprises (Longenecker, *et al.*, 2006). Infrastructure as it relates to provision of access roads, adequate power, water, sewerage and telecommunication has been a major constraint in the development of SMEs (Bokea, Dondo & Mutiso, 1999)

This aspiration to support SMEs has consistently been reflected in various Government policy documents such as the Sessional Papers and National Development Plans for example 1997-2001. Youth Enterprise Development Fund (YEDF) is another initiative which was formed in 2007 to stimulate economic opportunities for and participation by Kenyan youth. The fund expected to make you more entrepreneurial and create jobs for them (Youth Enterprise Development Fund, 2012. Vision 2030 is another initiative which was developed and launched by the Government of Kenya in 2007 as national planning strategy, Vision 2030

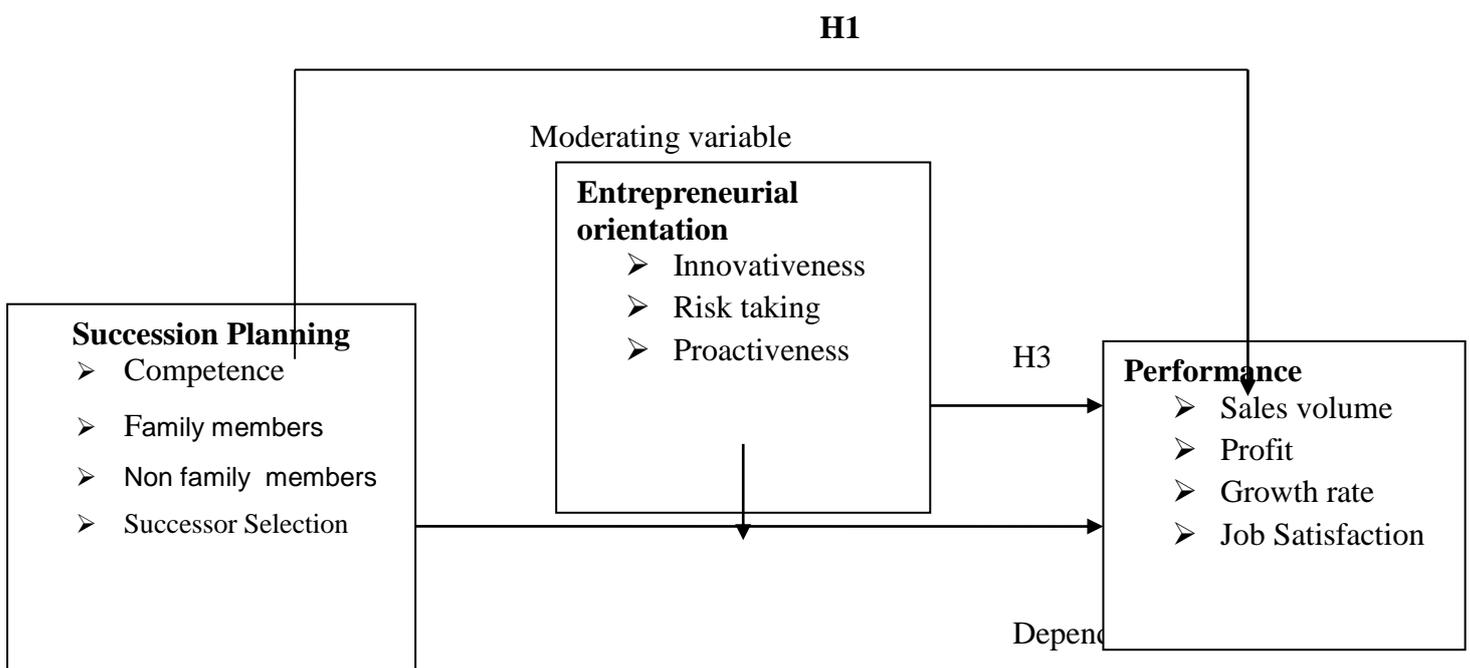
was born, its main pillars are Economic, Social and Political governance. The main objective of the vision 2030 is to make Kenya - a newly industrializing, middle income country and to improve the lively wood of Kenyans; the initiative will be implemented in successive five year Medium Term plans.

There is a major link between vision 2030 and entrepreneurial orientation especially that it is meant to maintain a sustained economic growth of 10% p.a. over a five year period (Kenya Vision 2030, 2012). The promulgation of the new constitution in August 2010 forms a very strong anchor for entrepreneurship as it provides the necessary legal framework for devolved government (National Council for Law Reporting, 2010). The county governance of the country will be based on democratic principles for efficiency and effectiveness for better and increased entrepreneurial activities, this is expected to improve the performance of the SMEs whose majority are Family business.

#### 4.0 Conceptual Framework

The literature review indicates that there are several variables that affect the relationship between Succession Planning and Firm Performance. Succession planning has an effect on the Firm Performance and the Entrepreneurial Orientation enhances the relationships between Succession Planning and Firm Performance.

FIGURE 4.2 CONCEPTUAL FRAMEWORK



The model presents Succession Planning as Independent Variable, EO as a Moderating Variable and Performance as the Dependent variable. The model will thus test and determine the relationships between Succession Planning and EO and Firm Performance.

### Hypotheses

The following hypotheses have been formulated for testing in the conceptual model:

H1: There is a direct relationship between SP and Family Business Performance.

H2: EO has a Moderating effect on the relationship between SP and Firm Performance.

H3: EO has positive relationship on Family Business Performance.

## **5.0 SUMMARY AND CONCLUSION**

Family businesses are complex and vary over a range of characteristics however, for a public or private business to be considered a family business, family members must have a controlling ownership interest and be actively involved in the business at the strategic level and thereby influence its strategic direction. Majority of the world businesses are Family Businesses, this is to the tune of between 65% to 90% depending on the country, further every existing business started as a family business.

Most studies have observed the positive relationship between the family business succession planning and performance, other indicate mixed findings between the two variables. Succession planning is not the most key contributor of firms success (Santiago, 2000), it is how well the business and family issues are tackled and therefore the relationship is moderated by family and other factors like entrepreneurial orientation.

It is important to have succession policies or plans in place. In the early stage of the business, the owner will control all key decisions and functions of the organization. As the business grows it gets more complex and therefore it is recommended that the business gets the owners to appoint capable managers who will be more qualified to handle the complex business functions. This is in contrast with many owners who will still want to retain control of the key business functions.

Replacing legendary managers is usually a very a big challenge, in most cases there are conflicts due to the incoming generation opting to pursue different interest other than the

family business. However there must be prudent planning for the business by both existing leaders and a third party, this may lead to smooth transition.

Lastly entrepreneurial orientation is key to success of family businesses, this is in terms of innovation, risk taking and being proactive to ensure that one takes full advantage of business opportunities. Considering that family businesses are economic power houses in terms of creation of employment, paying taxes and building vibrant societies all over the world, there is need to nurture them and ensure smooth transition ,this is the core reason for the study.

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# **Does Innovative Use Of Social Media Training Enhance Business Growth? A Case of Subira Self Help Group, Nairobi**

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## **ABSTRACT**

The general purpose of this study was to investigate the role of innovative entrepreneurial training programs on business growth among Subira Self-help group Nairobi. The innovative training included use of smart mobile phones to conduct business and market products, use of social media to reach customers and advertising of products by use of mobile phone technology. The study used a descriptive research design approach. The study sample was all the 48 members of the Self-help business group. A research questionnaire was used to collect the data. Descriptive statistics techniques were used to analyze the quantitative data. The researcher conducted regression analysis on the dependent variable aspect of business growth and the independent variable aspects of innovative business training programs (use of social media). According to the ANOVA results, the aspect of the independent variable was found not to be significant towards business growth represented by p- value of 0.324. We therefore accept the null hypothesis and conclude that business growth does not depend on innovative social media training. The study found that a unit increase in social media training programs led to an increase in business growth penetration by a factor of 0.146 but is weak. The study concluded that various types of business training programs were responsible for the business growth. The study therefore recommends that there is need for the members of the group to adopt and equip themselves with modern use of phone technology and applications that can grow businesses but still adopt other factors of business growth in the market. They should also be ready to be trained by field officers and colleagues on those programs that enhance business growth; since such programs portray positive impact towards business growth.

**Keywords:** Business growth, Innovation, Mobile phone technology, Training program, Social media, Self-help group.

## **1.0 INTRODUCTION AND BACKGROUND OF THE STUDY**

### **1.1 Background of the Study**

In the last three decades there has been a dramatic increase in the urban informal sector all across sub-Saharan Africa. Most of this growth has taken the form of an ever increasing number of very small enterprises, typically with no paid employees. The World Bank (2001) has shown that lack of access to business training and innovative opportunities, lack of affordable credit facilities is also a major cause of poverty in Kenya which leads to economic stagnation. Economic growth in industrialized as well as developing countries remains a central issue and, as such, particular interest is focused on the role of innovative entrepreneurship to achieve and maintain thriving and modern economies.

Subira self help group is a group of businessmen and women who came together, pooled resources in the name of revolving funds or Chamas as they are popularly known in Kenya to boost their businesses. The group lends money to individuals who are members of the group at a low interest rate of 10%. Besides lending, the group sources for experts in the area of business to offer training programs that may be of interest to them at a small fee. Among the training programs that have been offered is the use of social media to win customers and grow business networks.

### **1.2 Statement Problem**

In Kenya, there are many examples of businesses that have been started and operated by people who have received no formal training, financial aid, or extension assistance (Gully, Payne, Koles & Whiteman, 2002). Lack of current and innovative entrepreneurial training has led to businesses operating at below capacity and many business people are unable to enter the global market due to fear of competition and ignorance. Subira self help group had the capacity to pull resources and yet the individual businesses were not operating in a way to demonstrate growth and increase. As such it is essential to incorporate modern methods of training, namely: use of social media training programs to achieve growth and reach customers, rather than depend on physical clients only.

### **1.3 Research Questions**

This study was guided by the following research question;

To what extent does the use of social media training program affect business growth among members of the business group?

## 1.4 Hypothesis

H<sub>0</sub> (null hypothesis): There was no significant influence in business growth reported by entrepreneurs of the business group before and after social media training program

H<sub>1</sub> (alternate hypothesis): There was significant influence in business growth reported by entrepreneurs before and after social media training among members of the business group

## 2.0 THEORETICAL REVIEW AND LITERATURE REVIEW

### 2.1 Facilitation Theory (the humanist approach)

Facilitation theory developed by Carl Rogers and others in 1965 indicates that a facilitator has to be present for learning to take place the facilitator acts as a guide and creates an environment that is fit and comfortable for learning to take place. Dunn (2002) identified that people are always waiting and responsive to new ideas hence ready to learn. The learner is willing to change behavior especially when faced with unpleasant consequences.

The theory explains that facilitators are supposed to be responsive, accept feedback and are good listeners for learning to take place. The learner enjoys an environment that has a variety of activities and relevant training programs. Learning and training at given to Subira self help group members is handled by qualified and experienced facilitators who ensure that a conducive environment is in place, materials and equipments are set, while at the same time ensuring that the learning is well conducted. The facilitator selects staff of the right profile and puts them in work teams for better learning to take place. Any training that takes place has to be implemented for it to be effective; the facilitator also oversees and monitors the implementation process.

### 2.2 Forms of Social Media

There are different forms and categories of Social Media that can be used in business as introduced by Fridolf and Arnautovic (2011). The categories include to name bit a few: Blogs which are ideas posted online journals by firms, media images and copied links to various web pages; Social networks or groups are sites where individuals with similar ideas or concerns join together and develop one another through creation of online relationships; Content communities plan and organize information which is accessed and then shared by other people on the website: bulletin boards are those types of information that educate people on certain topics of interest and in process they allow people to exchange ideas on particular interest. Examples of social media sites commonly used by people both individually and for business purposes include: Facebook, watsup, MySpace, LinkedIn, Flickr and Instagram (Drury, 2008).

Social networks are accessed for various purposes among them: finding friends, conducting business, selling, purchasing products, exchanging ideas among others. For example LinkedIn connects with people in business and in the same profession and finding business partners. MySpace connects people in music and classmates can connect through classmates.com. For purposes of charting and creating friendships online, people use Facebook; while some people communicate through the use of twitter to pass messages (Flink, 2011). However, all channels have been turned to marketing channels with time

### **2.3 SOCIAL MEDIA AS A MARKETING TOOL FOR BUSINESS GROWTH**

Business people desire to belong to groups that will enhance their business and improve profits. The world has become a global village where people are now able to communicate easily, faster, widely concerning many aspects of life as well as connect to conduct businesses through online platforms (Lewis, 2010). Most organizations and individuals have realized the importance of this communication and network connection channel that enables sharing and bringing business opportunities to the firms. As a result, any business person is keen on ways of connecting with the other person or market to grow their networks, therefore using social media to create more business opportunities. Social networking has therefore become an important business reaching idea for both profit making and non-profit making organizations. However, as Lewis (2010) explains, despite this involvement, there is limited understanding of how social media can be well utilized to draw purchases and choices of users. It is with this understanding in mind that, the study will enable us to find out how effective this tool is and what else can be done to ensure it well utilized to bring growth to entrepreneurs. For this reason the company and individual has to choose wisely which social media channel to use to in order to carry out advertising campaigns or marketing of products (Kaplan & Haenlein, 2010).

Social media can be used as an advertising tool because it enables companies to communicate directly with customers about their products and with one another. The manager or business owner may however not be able to control communication between individuals and who are on the forum for example on 'watsup' or on 'face book'; it is usually beyond the control of the firm. The individuals may decide to communicate at odd hours and the frequency cannot be predetermined. This is contrary to the traditional methods of advertising and integrated marketing where business owners and entrepreneurs are able to direct communication and shape its flow (Bond, 2010).

Social media use has several advantages such as: it enables customers to engage in information sharing in a timely manner; it is affordable and comes at a fair cost, hence more efficient than

the traditional methods of advertising. Small firms as well as large firms can both benefit from social media at low costs. Most companies have a regular website but will from time to time turn to social media to advertise their products or get customer feedback concerning their services. This use of social media enables people and firms to reach many people and as fast as possible within a very short time as explained by Halligan & Shah (2010) in his study on inbound marketing and social media usage. Customers are able to use social media channels to communicate with one another about a product or service and therefore creating a lot of influence on a product, which could lead to purchase or rejection.

Another advantage of social media usage is the freedom that consumers are able to enjoy through the ability to make their own choices and not stick to brands which do not add them value. This means that the customers/consumers are able to control the information they get from organizations by blocking those they do not need and respond to information that they need. They later on learn to trust social media channels than the actual firms. For this reason, firms have to post information that should work to their advantage and respond quickly to those that can damage reputation. Consumers are able to share information of all types across networks and people end up engaging in debates concerning the firm's products which could then lead to purchase or shift as described by Keller (2009). Social media use can therefore be very challenging to the company because the customer has a free choice and free will. It is therefore up to the firm/organization to manage the information sent and received.

Social media being a strong marketing tool, it is not free from challenges that may discourage users such as: Negative posts on the Facebook concerning a product, exaggerated information, bias among others. These mentioned factors can cause consumers to lose trust in products offered by the firm or negative reactions can be generated from customers by information that is purely meant to push for sales. Another challenge is lack of time to make the company site attractive or update consumers. Lack of an updated website could lead to loss of sales due to customers withdrawing from the site. Return of investment on use of social media may also not be accurately measured due to lack of knowhow and uncertainty on investment, and lack of adequate knowledge on how to use social media for marketing purposes (Ghali, 2011)

For a firm to actively make use of social media in a way that will generate sales, then the firm has to remain open and sensitive to customer requirements. The products should be "pushed" gently while at the same time avoiding aggressive selling that could lead to conflict. Kingsland (2007) in his studies on finding business opportunities through use of social media

advice that a firm has to understand that, most people who participate on social networks are not purchasing but are doing so mainly for purposes of creating relationships. He explains that customer opinions should be valued and the firm sensitive to changing trends. This approach ensures that customers are not pushed through aggressive marketing and made to purchase products that do not suit them. Gruber (2004) agrees that customers should not purchase a product due to coercion, since it will lead to dissonance and hence failure of repeat purchases. The customers should be well managed by engaging them through feedback forms and getting their opinions and suggestions

#### 2.4 Entrepreneurial Education and Training

There is general agreement by researchers in the field of entrepreneurship that emphasis should be placed on entrepreneurship education and training. The Consortium for Entrepreneurship Education (2004) points out that entrepreneurship education is a life-long learning process and consists of five stages: basics, competency awareness, creative applications, start-up, and growth. For this reason, continuous training and learning are important tools that enable organizations to adjust well to the market and environmental changes taking place. Organizations are now becoming learning environments with managers taking the teaching role; employees the students.

Entrepreneurs require different skills and abilities that help them to achieve success in promoting innovation and creating business enterprise. They should predict the future and the changes that may occur in the ability of firms in justification and approval of establishing a business. This ability requires an understanding of the ever changing business environment and development strategies of markets and other new skills in the market so as to grow their businesses (Zahra, 2006). This training can be at three levels: business formation stage, performing stage and development should begin as early as the business formation level and end with exit. This type of training focuses areas such as: favorable business planning, selecting target markets, future profitability, financial planning, identifying competitors, designing new products and receiving rewards for success in business. Business performing training deals with general knowledge for business operations as described by Keller (2009). It includes measures such as financial planning, development of markets, maintaining current markets, understanding expected functions and transferring knowledge from entrepreneurs to managers. Personal development training should also be encouraged so as to foster confidence, leadership skills and critical thinking throughout the organization.

## 2.5 Measures of Business Growth

The category of success/performance is set as a dependent variable primarily in relation to management practice and the volume of management activities in small businesses in order to explain connections and possible influences in the direction of improving business results. Therefore, it becomes necessary to precisely understand and restrict the notions of success and performances that are usually used as synonyms. It is also necessary to define criteria which really measure success of small businesses. Success is a specific aspect of performance or is identified with high performance and increase in profits (Thiel, 2014). Some of them recognize success in growth and profitability, but this aspect has significant shortcomings in the field of small businesses where goals do not coincide, comparison and a real success statement are difficult to be presented, hence the need to look at other aspects of growth such as increase in number of staff employed, increase in stock, reduced customer complaints and diversification of businesses among others as described by Toivanen and Vaananen (2010).

Financial indicators are simple for success definition and statement, but they can ignore the possibilities of alternative criteria for success definition, based mainly on personal goals of owners/entrepreneurs/managers. The optimal level of performance regarding growth and development is therefore broad and should include other parameters and measures (Phelps, Adams & Bessant, 2007). However, it is noticeable for small businesses that personal success is identified with business success, while in other cases nonfinancial criteria and the lifestyle are far more significant. Besides usual and most used measures for the performance of profitability and growth (number of employees and amount of profit), some authors use business period as a practical measure of individual business satisfaction and personal success.

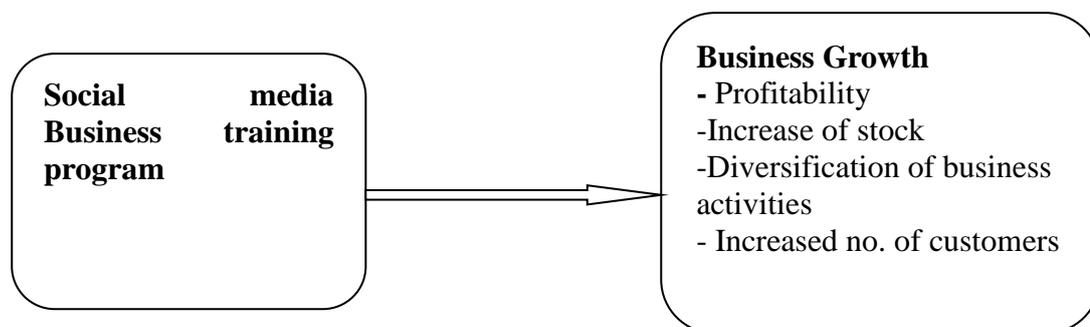
In a detailed analysis of success/failure of the small enterprise, business period and length of years in business can be a reliable indicator of success only if a small enterprise is closed down or business project is cancelled non-voluntarily, i.e. if it is a forced collapse (OECD, 2011). The forced closing down or business collapse happens after some period when it is impossible to continue with the business. This form of closure of business is explained as collapse or bankruptcy. On the other hand, business can be a voluntarily closed down (transition from self-employment to employment or unemployment) because of the lack of readiness or motivation. Generally, we can talk about voluntary and forced closure of own business, while survival as a measure of success of small business implies the period of doing business that will be ended by some forms of business closure without a new form of self-employment (to be self-employed in some period). Therefore, the measure of success of small business is determined by business period, which will be ended exclusively by forced and non-voluntary leaving of own business. Consequently, we can conclude that in case of the research on the sample of active small businesses, i.e. by researching the current owners/entrepreneurs/managers we can notice that the small enterprise with longer period of existence is more successful than the others as indicated by Thiel (2014). We can definitely agree that, due to problems of measuring success, especially in the early stages of small business, then other measures of growth are taken into account.

## 2.6 Conceptual Framework

The conceptual framework below represents the use of designed social media innovative training programs to enhance business growth. This conceptual framework indicates that a training program has to be in place for a successful measure of growth and outcome. As mentioned, facilitators used training methods and programs that allowed for implementation of acquired knowledge. Growth was measured by the following outcomes increase in profits, expansion of business, increased stock and diversification of business activities.

### Independent variables

### Dependent



### Variable

Figure 2.15: Conceptual framework

### 3.0 RESEARCH METHODOLOGY AND DESIGN

This section explained the steps that were followed in conducting the research. The study adopted a descriptive survey design which aims at determining the role of entrepreneurship training on business growth. Leedy and Ormrod (2005) explains that a descriptive survey design is appropriate because it is seen as an efficient method of collecting original data from many respondents a wide range of respondents given a short time. Target population as defined by Mugenda and Mugenda (2003) is a group of items or objects where a sample is drawn because of the similar characteristics. The target population for this research was all members of the self help group who were 48 in number. Thus a census population of 48 respondents was taken to increase the representativeness of the sample, minimize sampling errors.

A research questionnaire was issued to the respondents to collect data and allow the researcher to reach a wide population of respondents. The questionnaire had both open ended questions and closed ended questions. Data was analyzed using quantitative means by use of Statistical Package for Social Sciences (SPSS). The hypothesis was structured to ascertain the extent to which social media training programs affect business growth in the study.

### 4.0 DATA ANALYSIS AND PRESENTATION

All the 48 questionnaires were returned duly filled; giving the study a response rate of 100%.

#### 4.1 Demographic information

##### 4.1.1 Age of respondents

Majority of respondents were between the ages of 31 and 40 years represented by 50%, as indicated on table 4.1 below, while those between 41 and 50 years old were represented by 43.8%. Only 6.3% of the respondents were over 50 years of age. It showed a mature population in business

**Table 4.1 Age of respondents**

	Frequency	Percent	Cumulative Percent
31 years to 40	24	50.0	50.0
41 to 50	21	43.8	93.8
Above 50	3	6.3	100.0
Total	48	100.0	

##### 4.1.2 Marital status and Sex of respondents

Majority of respondents were married as represented by 60.4% as shown on table 4.2 below. Single people were represented by 22.9%, divorced were 12.5%, while widowed were 2%. We can assume that there was support in business operations from spouses.

Majority of respondents were females represented by 64.6% while the males were represented by 35.4%; meaning females in business were more than the males by 29.2%

**Table 4.2 Marital status of respondents**

	Frequency	Percent	Cumulative Percent
single	11	22.9	22.9
Married	29	60.4	83.3
divorced	6	12.5	95.8
Widowed	2	4.2	100.0
Total	48	100.0	

#### 4.1.3 Educational level of respondents

The study sought to find out the educational status of respondents and it established that majority were well educated business people with 72.9% having tertiary education and hence the training type would be well understood and comprehended. Those with ‘O’ level education were 16.7% and 10.4% did not indicate their level of education.

**Table 4.3 Education level of respondents**

	Frequency	Percent	Cumulative Percent
O level	8	16.7	16.7
Tertiary	35	72.9	89.6
Not indicated	5	10.4	100.0
Total	48	100.0	

#### 4.1.4 Businesses owned by respondents

The study established that the respondents sampled by the study carried out various business operations. According to the results, majority of the respondents were in agribusiness represented by 27.1%; followed by majority in general shop and retail outlets represented by 22.9%, catering / baking and hotel management were 14.6%, Clothing/ uniforms/boutique (12.5%), Salon and hair accessories (10.4%), Business consultancy (4.2%) and other business operations were represented by 4.2% in that order.

**Table 4.4 Types of businesses**

	Frequency	Percent	Cumulative Percent
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catering	7	14.6	14.6
General shop	11	22.9	37.5
Grocery	2	4.2	41.7
Agri business	13	27.1	68.8
Consultancy	2	4.2	72.9
Clothing	6	12.5	85.4
Salon	5	10.4	95.8
Other	2	4.2	100.0
Total	48	100.0	

#### 4.1.5 Forms of business ownership

The study established that most businesses were owned by sole proprietors represented by 62.5% and family owned businesses were represented by 27.1%. The study also established that partnership owned businesses were 2.1% while 8.3% of respondents had registered their businesses as company limited.

**Table 4.5 Forms of business ownership**

	Frequency	Percent	Cumulative Percent
Self proprietor	30	62.5	62.5
Family	13	27.1	89.6
Partnership	1	2.1	91.7
Company limited	4	8.3	100.0
Total	48	100.0	

#### 4.2 Use of social media in transacting business operations after training

The study sought to find out from respondents on how often they used social media to transact businesses after training. The findings are illustrated on table 4.6 below as follows: 45.8% of respondents use social media to a moderate extent, while 41.7% use it to great extent and 12.5% to a less extent. The study can therefore conclude that the number of respondents who used social media to engage in business activities after training was quite high giving a total of 87.5%.

**Table 4.6 Use of social media in business transactions**

	Frequency	Percent	Cumulative Percent
Little extent	6	12.5	12.5
Moderate extent	22	45.8	58.3
Great extent	20	41.7	100.0
Total	48	100.0	

#### 4.3 Type of social media channel commonly used

The study sought to find out the type of social media that was commonly used or preferred and the respondents indicated their preferences. Watsup 37.5%, those who used different combinations was 39.6%, Instagram was 16.7% while Facebook users were represented by 6.3%.

**Table 4.7 Type of social media channel commonly used**

	Frequency	Percent	Cumulative Percent
Facebook	3	6.3	6.3
Watsup	18	37.5	43.8
Instagram	8	16.7	60.4
Combination	19	39.6	100.0
Total	48	100.0	

#### 4.4 The role of social media on business growth

The study sought to establish the respondents' level of agreement on whether social media training and usage had improved their businesses in terms of growth, increase in profits, and increase in number of customers among other parameters. Respondents agreed as indicated on table 4.8 below that there was improved profits represented by a mean 3.79; influence of social media on business growth with a mean of 3.23 and reported improvements after training represented by a mean of 3.50. According to the results displayed on the table 4.9 below majority of the respondents were in agreement that they have managed to post improved profits as represented by 22.9%; the number of customers had increased (29.2%); complaints had reduced since training as represented by 4.2% of respondents; 16.7% of respondents said they had increased stock levels and 22.9% had noticed growth represented by a combination of factors. Service had also improved as represented by 4.2% because customer complaints were handled early and suggestions made by customers had been implemented or addressed.

Table 4.8 Descriptive statistics on the role of social media on business growth

	N	Minimum	Maximum	Mean	Std. Deviation
Improved profits	48	3	4	3.79	.410
influence of use of social media on business growth	48	2	4	3.23	.857
Improvements after training on social media usage	48	2	4	3.50	.619
Valid N (listwise)	48				

Table 4.9 Specific Improvements after use of social media

	Frequency	Percent	Cumulative Percent
Increased profits	11	22.9	22.9
Number of customers	14	29.2	52.1
Improved service	2	4.2	56.3
Reduced customer complaints	2	4.2	60.4
Increased stock	8	16.7	77.1
Combination of growth factors	11	22.9	100.0
Total	48	100.0	

#### 4.5 Statistical Analysis

##### *Correlation matrix of social media training on business growth*

The result on table 4.10 below indicates the correlation matrix between social media usage and business growth is slightly positive in nature at 0.146. According to the result, there is a positive influence of magnitude but the relationship of influence is weak since the magnitude of influence is low at 0.146.

**Table 4.10 Correlation matrix of industry size on adoption of system**

		Improved growth	Use of social media
Improved growth	Pearson Correlation	1	.146
	Sig. (2-tailed)		.324
	N	48	48
Use of social media	Pearson Correlation	.146	1
	Sig. (2-tailed)	.324	
	N	48	48

*Regression Analysis of social media training and business growth*

The study conducted regression analysis to establish the relationship between the study variables which were: influence of social media use on business growth. The information on table 4.11 below indicates that adjusted R square of 0.000 means that the variables studied contribute to 0% of the factors that influence growth of business and hence other factors contribute to 100% of the growth. Since the R is 0.021, a conclusion can be made that innovative training is positively correlated with the growth in business but the relationship is very weak since R is close to 0.

**Table 4.11 Model summary**

<b>Model Summary</b>				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.146 <sup>a</sup>	.021	.000	.410

a. Predictors: (Constant), Use of social media

*ANOVA results*

From the ANOVA results on table 4.12 below, the p-value is 0.324 greater than significance level of .05; meaning the level of influence of social media and business growth is not significant; hence we accept *the null hypothesis that* there is no significant influence in business growth reported by entrepreneurs of the business group before and after social media training program

**Table 4.12 ANOVA results of social media training on business growth**ANOVA<sup>a</sup>

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	.168	1	.168	.995	.324 <sup>b</sup>
1 Residual	7.749	46	.168		
Total	7.917	47			

a. Dependent Variable: Improved growth

b. Predictors: (Constant), Use of social media

### *Regression Coefficients of social media on business growth*

The data findings presented on table 4.13 below indicate that taking all other independent variables at zero, a unit increase in use of social media leads to a 0.087 increase in business growth; the increase is quite minimal in nature not indicating significant change in the training given.

**Table 4.13 Regression coefficients of social media training on business growth**

Coefficients <sup>a</sup>					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error			
(Constant)	3.504	.295		11.893	.000
Use of social media	.087	.088	.146	.998	.324

a. Dependent Variable: Improved growth

## **5.0 CONCLUSIONS AND RECCOMENDATIONS**

### **5.1 Conclusions**

The study concludes that social media training programs are responsible for the business growth among members of the self help group. The study concludes that the innovative social media training program (related to business formation, business development, business performance) influences business growth to a little extent. The hypothesis test was however not significant which led to acceptance of the null hypothesis that there was no significant influence of social media on business growth as represented by a p-value of 0.324 which is bigger than level of significance

Various roles of the influence of training programs were established which were profitability, customers increase, reduced customer complaints, increased business stock and diversification of business approaches. The study also concluded that there was general consensus to promote social media training and usage at all levels of business. Entrepreneurship education and training

can make a positive contribution to employee morale and productivity, hence enhancing business growth.

## **5.2 Recommendations**

The study recommends that there is need for the members to adopt and equip themselves with more innovative entrepreneurial programs other than social media usage since social media is cheaper and has a positive impact towards business growth. Under the theme *entrepreneurial process*, the following aspects should be covered in the training programs: how to create jobs, dealing with unemployment; tax returns; personal and financial management; industry knowledge; new business idea development, e.g. searching for innovative business ideas; creativity and innovation. This helps them understand on the issues and the way to handle them.

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**A Social Enterprise, Better Maternal Health Services through Mobile Messages  
Automated-System, a Pilot Study In Aic Kijabe Hospital, Kiambu County.**

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**ABSTRACT**

There is a tremendous need to increase patient specific approaches to reduce barriers to care and enhance compliance of healthier strategies for pregnant women. Digital innovation is a text messaging platform allowing individually targeted gestation, appropriate health information delivered directly to pregnant women and household level decision-makers. To test technical feasibility and client acceptability; MamaTips was founded in 2016 as free messaging subscription service promoting healthier pregnancy and delivery in a Kenyan context. MamaTips sends health messages through automated-system to enrolled pregnant women in English/Swahili that corresponded to their gestation week for 6 months; educating them on living healthy, pregnancy danger signs and preparedness for safe delivery, leveraged by high mobile phone penetration in Kenya. MamaTips built on work done by Mobile Alliance for Maternal Action (MAMA) adapting and implementing health messaging approach in Kenya targeting women in rural and semi-urban settings. Health-oriented text messages of 160 characters were contextualized by Medical and nutrition experts from Kijabe Hospital and Participants were recruited from outpatient antenatal clinic in Kijabe Hospital. Out of 40 women invited 37 enrolled; 97% participated through the study or until they delivered (N=36), 90% shared messages (47% orally, 21% forwarded and 32% read through recipients' phones). 95% would re-enrol and recommend others. 74% would pay for such services if re-enrolled for average of Ksh 86. Language appropriateness was 100%. The study identified technical problems with 66% receiving all messages each week, but once identified solutions resulted to all messages being delivered. MamaTips successfully delivered individualized gestational appropriate series of health messages this exhibited desirable and potential to develop a financially sustainable platform through subscription service.

**Keywords:** Automated-system, m-Health, Maternal Health, Digital Innovation, Social Enterprise

**Introduction**

In a bid to increase awareness among pregnant women on the importance of proper health care practices during pregnancy in Kenya, MamaTips was founded in 2016 as a messaging subscription service that sends them important health information related to pregnancy as recommended by the World Health Organization(WHO). Through an automated system, MamaTips progressively send the enrolled pregnant women weekly messages with tips and information on how to actively lead a healthy life during and after pregnancy for the sake of a

safe pregnancy and delivery. The primary target was women in rural or semi-urban settings where mothers may have limited access to information and education. By leveraging on the high mobile phone penetration in Kenya (currently at over 88%), MamaTips is able to reach a large number of women conveniently and efficiently, giving them information and updates right in their hands. The platform used for the dissemination of this information is an automated system that sends weekly messages that are in line with the mother's gestation stage, educating them on how to live healthy, be aware on danger signs during pregnancy and delivery, and tells them how to best prepare for safe delivery at a hospital or clinic also as part of individual birth plan. MamaTips builds on work done by the Mobile Alliance for Maternal Action (MAMA) and is adapting and implementing this health messaging approach in the Kenyan context.

In the span of six months with a budget of \$2000, MamaTips kicked off its pilot program at the AIC Kijabe Hospital Antenatal Clinic. The feedback received from the women who enrolled from the service and some of the maternal health professionals helping us at Kijabe goes a long way to show that pregnant mothers appreciate information given to them during pregnancy, and that they are willing to go the extra mile in ensuring that they have a healthy pregnancy and consequently a healthy baby.

### **Background of the study**

Maternal mortality at childbirth and newborn mortality are still occurring at a very high rate in sub-Saharan Africa. In Kenya alone, 6000 to 8000 mothers die during childbirth every year (360 of 100,000 births). Every year 40,000 newborns die within the first month of life (200 per day) and 33,000 newborns die preterm. Kenya is ranked 10<sup>th</sup> as the riskiest places to deliver a baby in. The Kenyan government has adopted the United Nations millennium development goals (MDGs) 4 & 5 as their own and the First Lady from Kenya has spearheaded the Beyond Zero campaign to improve maternal deaths to 122 per 100,000 births.

Access to good healthcare is variable in Kenya, and it is affected by the circumstances a mother finds herself in within her community. Even with free deliveries at health care facilities (since July 2013 by presidential decree), many mothers end up delivering their babies at home with unskilled attendants. When a pregnant woman delivers at a health facility, they are increasing their chances of having a successful delivery with a healthy mother and newborn. In Kenya 40% of women deliver without the help of a skilled birth attendant yet 96% of women have accessed at least one antenatal care visit out of the four ANC clinic recommended by WHO.

Education on pregnancy, fetal development, neonatal care and early childhood development are sadly lacking in the Kenya urban and semi-urban pregnant women. Women who are less aware of potential complications are more likely to deliver at home and less likely to respond promptly

to danger signs. A study in rural Tanzania demonstrated that 42% of patients in antenatal care were not informed of danger signs during pregnancy.

The need for women to be informed about their pregnancy, education on how to be healthy during pregnancy, the development of the unborn child, and danger signs presents a tremendous opportunity to support women through their pregnancy using mobile phones. According to the Communications Authority of Kenya, the mobile penetration of Kenya has hit 80.5%, meaning that a vast majority of Kenyan households have at least one phone. This makes mobile phone delivered messages educating women about their pregnancy able to reach thousands of women.

AmmiTips and mMitra are organizations providing these phone based educational services in Pakistan and in India (<https://www.youtube.com/watch?v=HAGrEtVe9YE>). We will be using the AmmiTips technology and communications system, as well as evidenced based messages developed thru the Mobile Alliance for Maternal Action (MAMA) in the communication of specific messages (<https://www.youtube.com/watch?v=T5NepnL8vFA>). The Mobile Alliance for Maternal Action in conjunction with other partners including Stanford University and BabyCenter have been developing messaging for pregnant women and their children and have developed the evidence base and the scope and sequence of the messages. The academic framework for behavior change was developed by BJ Fogg at Stanford University Persuasive Technology Laboratory <http://captology.stanford.edu/> in conjunction with BabyCenter, a group that has worked in delivering health-care messages to over 24 million parents around the world each month. The MAMA project with the help of its partners and their experience has developed a model that is felt to deliver age- and stage-based messages improve maternal knowledge, and builds an emotional relationship with the parent which creates trust. The MAMA project and others like it Text four baby in the US have demonstrated uptake and feasibility in promoting health messages for women and infants. The project aims were to begin to develop a platform for public private partnerships that will allow adaptation of this idea for sub Saharan Africa.

These text messages were contextually adapted as per the MAMA protocol and recorded and then automatically sent via the AmmiTips automated voice and text messaging platform through Echo mobile. The prototype messages and the automated platform (including maintenance of that platform) are donated to MAMATIPS.

Depending on the stage of pregnancy, the MAMATIPS educational service could regularly text the women who enrolled to Mamatips service at a frequency of about twice every week (the women time were determined by Echo mobile (that acted as service provider or the text dissemination centre).

Mamatips Pilot study sought to utilize mobile phones and messages to; educate women about healthy pregnancy and delivery, better understand how to improve this mobile phone service to

better meet their needs and better understand the cultural and social norms that drive decision making towards health seeking behaviors. This could also allow the project help the health systems to develop effective solutions for the local community.

This project worked as a small-scale FEASIBILITY study using individual phone interviews to follow up the women who receive MAMATIPS messages. In the initial pilot the phone interviews focused on process and if the system worked. In addition, the project wanted to know what mothers learned from the messages.

A small-scale feasibility study aimed at building a platform to develop more extensive public private partnerships, since broad scale roll out and developing the scientific evidence base for the effectiveness is a substantial endeavour and would require collaborating at national and international levels. The MAMA model “is based on the expectation that women’s and families’ increased access to targeted health information will lead to improved knowledge, behaviours and practices, and in turn, those improvements will lead to improved health outcomes. Each of MAMA’s three current country programs; Bangladesh, South Africa and India, has identified intermediate level health outcomes related to change in knowledge, at home preventive behaviours and seeking of health services that are measurable, relevant and within the realm of influence of each MAMA program.

However, the opportunity to understand the multiplicity of influences that drive judgment and decision-making processes at the community and household level will be incorporated in future steps. The follow up mobile text was to provide a feedback loop for improvement of message content and provide insight into household level maternal health decision-making.

### **Research Objectives**

The broad objective of this study was to explore and gain a better understanding of the cultural and social norms that drives decision making towards health seeking behaviors, specifically the experiences of women who were using the MAMATIPS messages texting services in order to understand how to improve:-

- i. The educational benefit for these women and their families.
- ii. Understand women’s and family members (households) perceptions of how to have a healthy pregnancy and what they think of the health care available to them.
- iii. Better understand the cultural and social norms that drive health seeking behaviors.

### **Study Aim/Specific Objectives**

- i. To study on how can we improve the MAMATIPS educational message to benefit the pregnant women and their families?

- ii. What are the household members' perceptions on how to have a healthy pregnancy and of their health care options?
- iii. What are the cultural and social norms that drive decision making and health seeking behaviors of pregnant mothers?

### **Assumptions of the study**

- i. The mothers enrolled are representative of all the social groups of mothers countrywide.
- ii. The mother enrolled willing to read the text sent and could understand them in the language of their choice that that is English or Swahili.
- iii. All the enrolled mothers lived in areas where network coverage was good and could receive all the three text messages on Saturday and Sunday.
- iv. All the enrolled mother would not reject the services of text messages

### **Scope of the study**

This study centre was located in AIC Kijabe in Kiambu County through the MCH/Family Clinic. The program anticipated expansion to enroll women from other sites after the initial pilot evaluation.

### **Study Design**

The study was prospective whereby women enrolled in the MAMATIPS free messaging service were followed and their feedback was received and noted electronically. The data collection methodology utilized the semi-structured phone interviews. Other approaches included some document review and site visits that examined ease of enrollment of participants by health provider at their local clinic setting and AIC Kijabe Hospital MCH/Family Clinic.

### **Participants**

Pregnant Mothers of reproductive age (WHO, 15-49 years) who were recruited to the message service during antenatal care visits are the main participants with a Kijabe Maternal and Newborn Community Heal Project (KMNCHP) team that will act as validity assessment team. In the future, women will also able to sign themselves up if they have a Safaricom card and mobile phone if they are referred by a friend. All women who participate in the MAMATIPS educational messaging service were eligible for interviews to give feedback on how the service if it met their needs. The participants reflected the range of economic and educational sectors in Kenya and therefore represent the diversity present in the Kenya. The initial languages used were English and Kiswahili that were preference to the pregnant mothers enrolled.

### **Study Risks and Limitations**

Lack of cell phone could reduce participation of some women. A cell phone that works was required to

receive the messages and to give follow up feedback. In poor households men may have the cell phone but not women. In these cases a woman was required to coordinate with the husband to be present at the day and time the text message was received or be shown the text message. Though the cell phone penetration in Kenya is very high, another potential limitation is that cell service may intermittently have poor reception or other difficulty. This is an area where the feedback would be helpful to see if women were having reception difficulty. Again, in Kenya the areas of cell phone service are expanding. The funding were sufficient project initial pilot to be able to include individuals who subscribed to smaller cell service providers if that proves to be a limitation.

Cultural barriers: Particular views towards research studies may affect the data collection process if not looked into and mitigating measures taken into consideration depending on the areas where the study will be conducted. Since women will be asked if they are in a comfortable place and if they have time to answer some questions on the phone there will be the opportunity for them to either get a call back or move to a more appropriate location to do the feedback call

Integrity issues: Potential respondents may request for financial incentives for them to participate. No financial reimbursements were given to the participants and the personnel's' who participated in all processes that included transcribing to recruitment.

### **Implementation**

Active enrollment of mothers took place between May 30<sup>th</sup> and June 2<sup>nd</sup>, 2017, with 37 women and 11 Kijabe testers signing up for the service (See figure 1 in Appendix for the invitation letter used). Messages were sent out beginning the weekend of June 3<sup>rd</sup> until September 28<sup>th</sup>, 2017, at the following times: 1800hrs Saturday, 1500hrs Sunday and 1800-1830hrs Sunday. These times were chosen as the most ideal time when mothers are not as pre-occupied as other times during the week. Two surveys, a feasibility survey and acceptability survey were sent within this period, allowing us to get feedback from the mothers on how they found the service. The pilot phase was officially closed on the 28th of September, after which we reconciled our finances and analyzed our data, as detailed in the following sections.

### **Finding**

The findings of Mamatips pilot study was analyzed by calculation of percentages and presenting the same in the tables, pie charts and bar graphs.

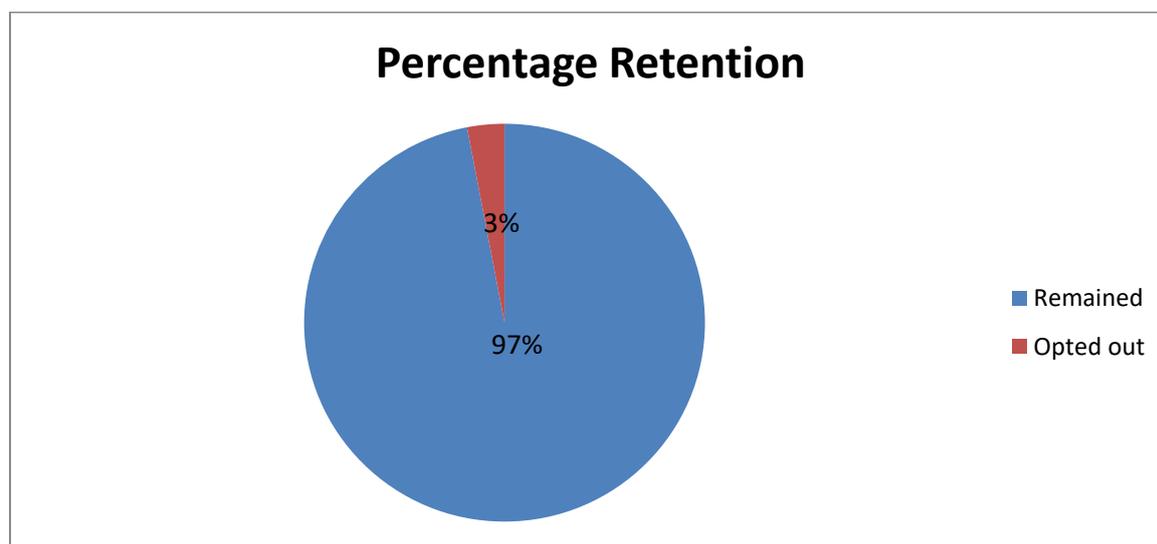
*The table below shows the Percentages of pregnant women enrolled and number invited*

Particulars	Numbers	%
<i>women invited</i>	40	100
<i>women enrolled</i>	37	97

The table above shows the women invited in comparison to those who enrolled that is 40 and 37 women respectively making 97% of the enrolled women.

The table below shows the Number of women who opted out of the service before they delivered their baby

Particular	Number	Percentages
Total enrolled	37	100
Remained	36	97
Opted out	1	3

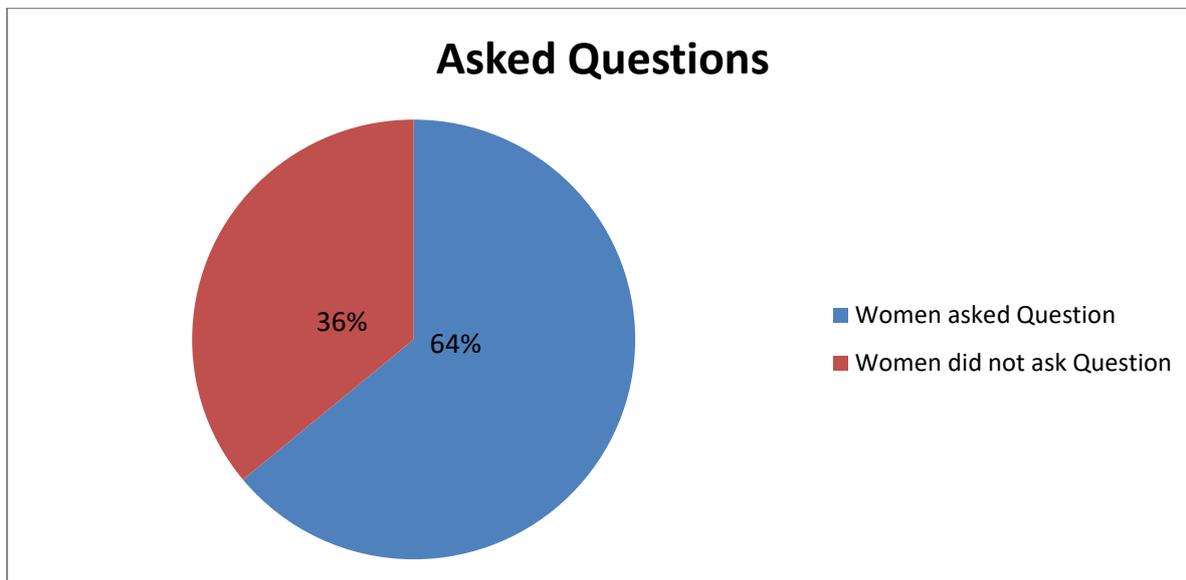


11 testers from the Kijabe team, comprising doctors, nurses and public health professionals, both men and women, were also enrolled to allow them to experience the service and give critique it for improvement. The first survey was sent about four weeks into the pilot to investigate the efficiency of the mobile platform. There was a 98% response rate. The second survey was sent after about 8 weeks into the pilot to investigate the reception of the service by the mothers, and whether they found the platform useful. There was a 45% response rate. (Note: some women had delivered while a few had opted out).

The following survey results reflect the feedback given by both the mothers enrolled and the testers and none of the surveys was mandatory.

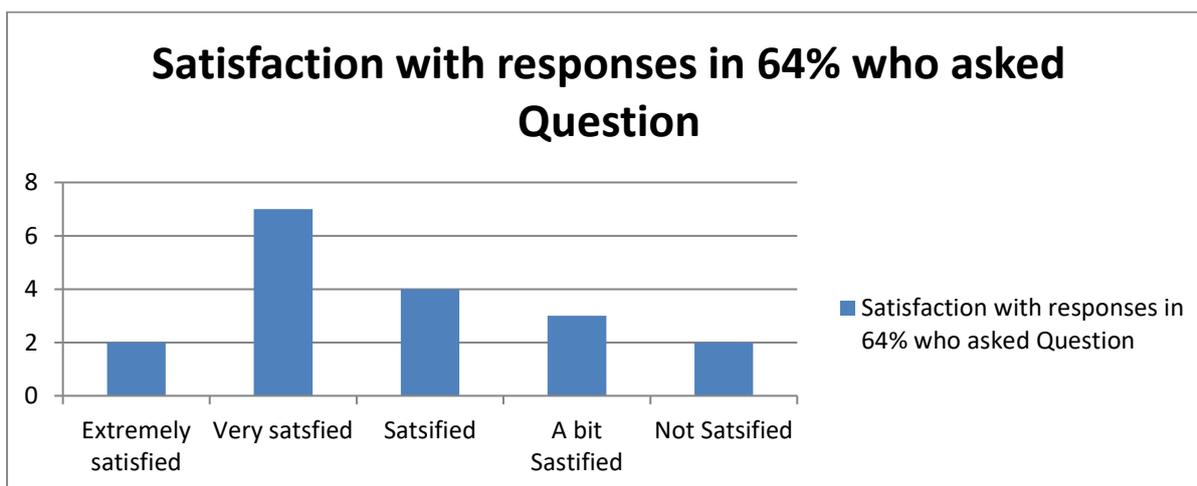
The table below shows the Percentage of women who sent questions to MamaTips via text messages, and of those who did, number that was satisfied with the quality and speed of response sent back to them

Particulars	Numbers	Percentages
Asked Question	23	64
Did Not Ask question	13	36



The table below shows the Number of women that was satisfied with the quality and speed of response sent back to them

satisfied	Numbers
Extremely	2
Very	7
Satisfied	4
A bit	3
Not	2



The answers given were strictly from the information we had in our messages, as these were already reviewed by medical professionals. Questions asked about any topic we did not have information on in our messages would be referred to the health workers in the clinic. The length of the response was, unfortunately, limited to 160 characters which is the standard for SMS.

Most times, the lag between receiving a question and answering it was anywhere between 1- 3 days, as the platform was monitored by one person only, so we encouraged mothers not to contact us for urgent matters. Examples of question-answer sessions with background on reason for asking question (phone numbers redacted for customer privacy):

- *Mother's curiosity:*

2017-07-24 22:38 UTC SMS  
**Echo:** Answer: Yes, you may ask a question. If we do not have the answer in our messages, we shall refer you to the health workers at the clinic.

2017-07-24 22:40 UTC SMS  
 254700070000 I want to know the side effects of epidural CS. Thank you

2017-07-24 23:55 UTC SMS  
**Echo:** Answer: We highly recommend that you discuss this with your doctors, as they will be able to access your individual case and give you more accurate information.

2017-07-27 9:29 UTC SMS  
 254700070000 Thank you. Sometimes my baby kicks in a way that i feel like shock waves running from my belly downwards to the cervic. Is that normal? And why is that so?. Thank you

- *Mother wants to know what is normal during pregnancy:*

2017-06-14 6:41 UTC SMS  
 254700070000 How many times is the baby supposed to kick in a day

2017-06-14 6:41 UTC SMS  
**Echo:** Thank you. We have received your query and we will get back to you shortly.

2017-06-15 3:43 UTC SMS  
**Echo:** Message for week 33: At this stage, you will notice that your baby is kicking more. You should be able to count more than 10 kicks a day.

2017-08-02 8:11 UTC SMS  
 254700070000 haey,if somebody is in the last week for pregant is it normal to vomite ?

2017-08-02 19:03 UTC SMS  
**Echo:** Answer: Vomiting is not mentioned in any of our messages for the last stage of pregnancy, advice you to consult with your health workers at the clinic.

2017-08-02 19:06 UTC SMS  
 254700070000 thanks for the response

- *Mother anticipates certain occurrences and wants to be better prepared:*

2017-06-03 15:54 UTC SMS  
 254700070000 How do i know am in labour?

2017-06-03 16:38 UTC SMS  
**Echo:** When you start labour, you may see a jelly-like discharge. The main sign is contractions. At first, they may feel like mild tummy cramps or low backache.

- *Mother seeks information about her pregnancy (some women initially assumed that we were directly linked to their clinical records)*

2017-07-18 7:05 UTC SMS  
 [REDACTED] Hi,how many weeks am I, edd 2nd December

Translate

2017-07-19 0:17 UTC SMS  
**Echo:** Answer: According to our records, you are 20 weeks pregnant. We suggest that you confirm this with your health worker at the clinic.

Translate

- *Mother wants to get more information after receiving a message from MamaTips:*

2017-07-23 15:15 UTC SMS  
**Echo:** Smoking harms you and your baby. If you smoke, your baby could be born weak and catch infections easily. Stop smoking and avoid smoky places.

Translate

2017-07-23 15:17 UTC SMS  
 [REDACTED] what about perfume?

2017-07-24 22:46 UTC SMS  
**Echo:** Answer:We apologize,we do not have any messages regarding perfumes.Please consult with your health worker at the clinic who will be able to answer your question

Translate

- *Some women, after delivering their baby, would ask for information on how to best raise their baby:*

2017-07-09 14:52 UTC SMS  
 [REDACTED] Give me tips on how to take care of my baby

Translate

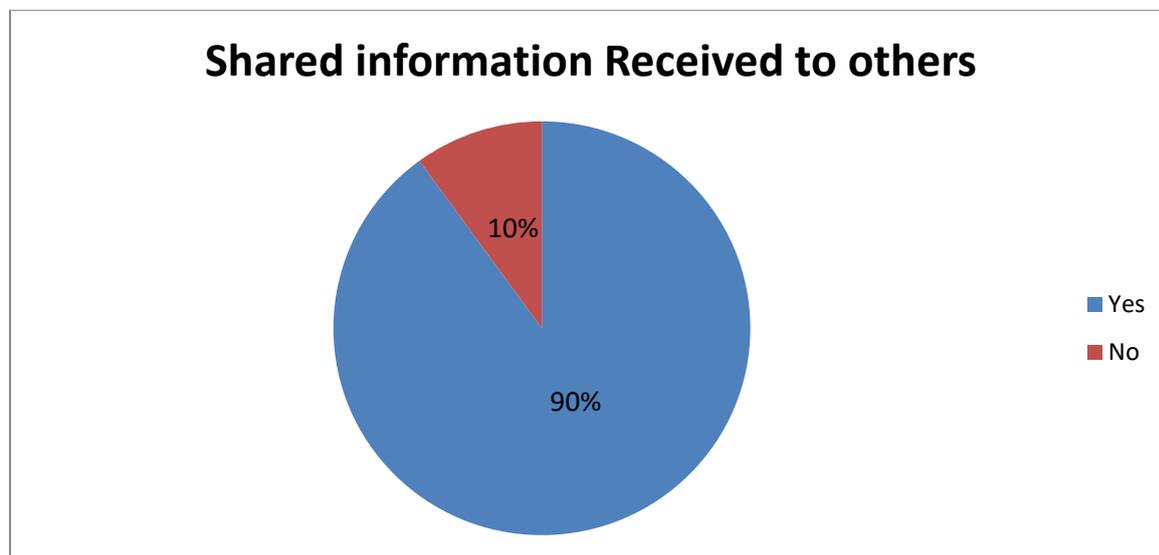
2017-07-09 17:21 UTC SMS  
**Echo:** We have not rolled out our baby messages yet. We refer you to [www.babycenter.com](http://www.babycenter.com) where you can subscribe to emails on how to take care of your newborn. Thanks.

Translate

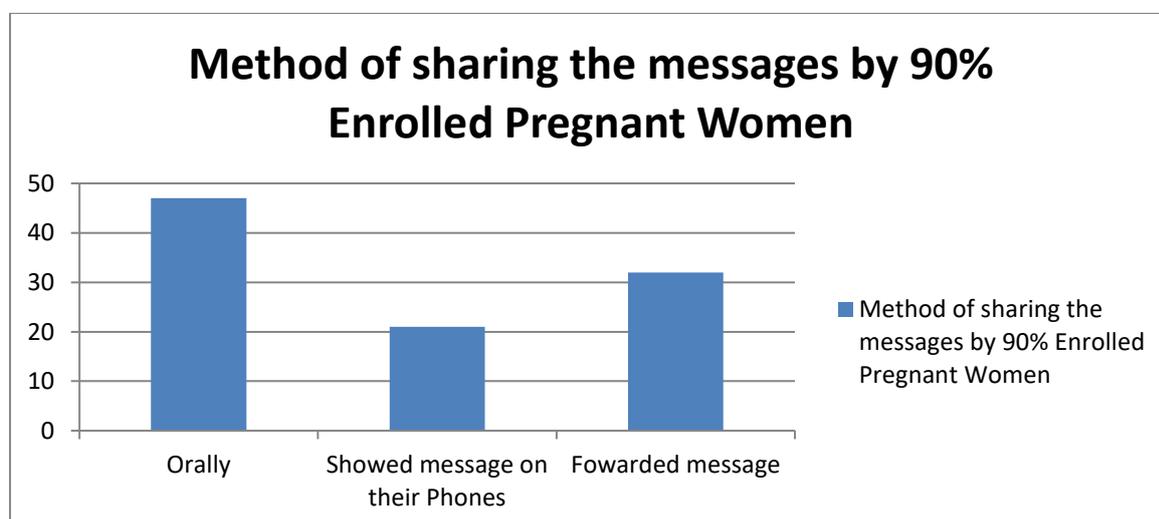
While MamaTips already has messages for raising newborns, they were not part of the plans for the pilot phase, and so had not been proof-read by any health professional. They therefore could not be sent out to the general population.

The table below shows the Percentage of women that shared information they received with others, and of those who did, the method of sharing used.

Particulars	Numbers	Percentages
Shared information	32	90
Did Not share information	4	10



The table below shows the Percentage of women that shared information they receive and the method of sharing used.

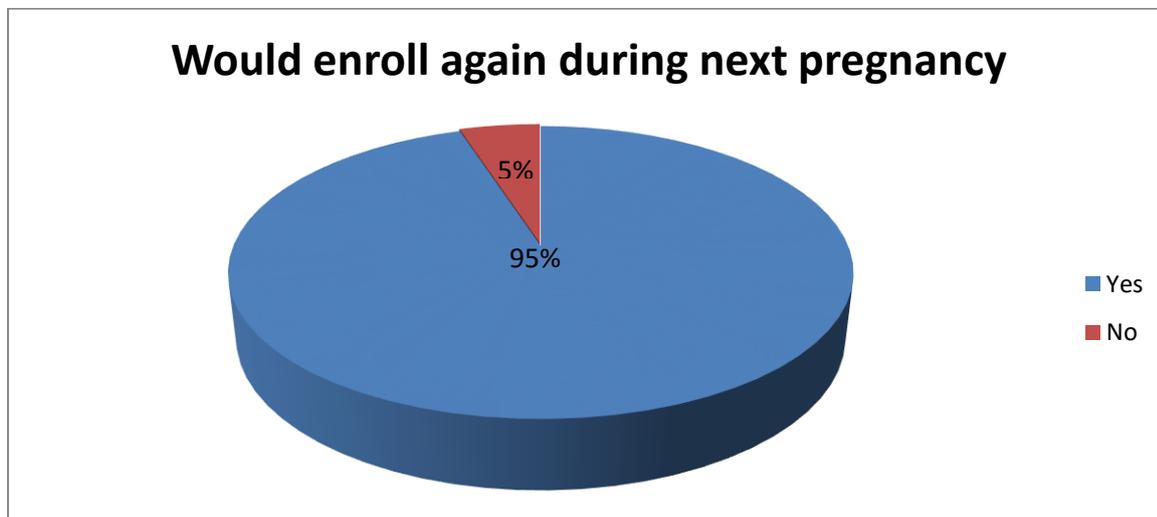


The high percentage of mothers who shared information received indicates that they found the messages from MamaTips to be useful. This also confirms that it would be helpful to set up the Accountability partner program where the mother would choose someone close to them, such as a spouse, sister or friend, to be receiving the same messages as them. This would help those around the mother to understand pregnancy more and so be better positioned to support her.

The table below shows the Percentage of women that would re-enroll for the MamaTips service

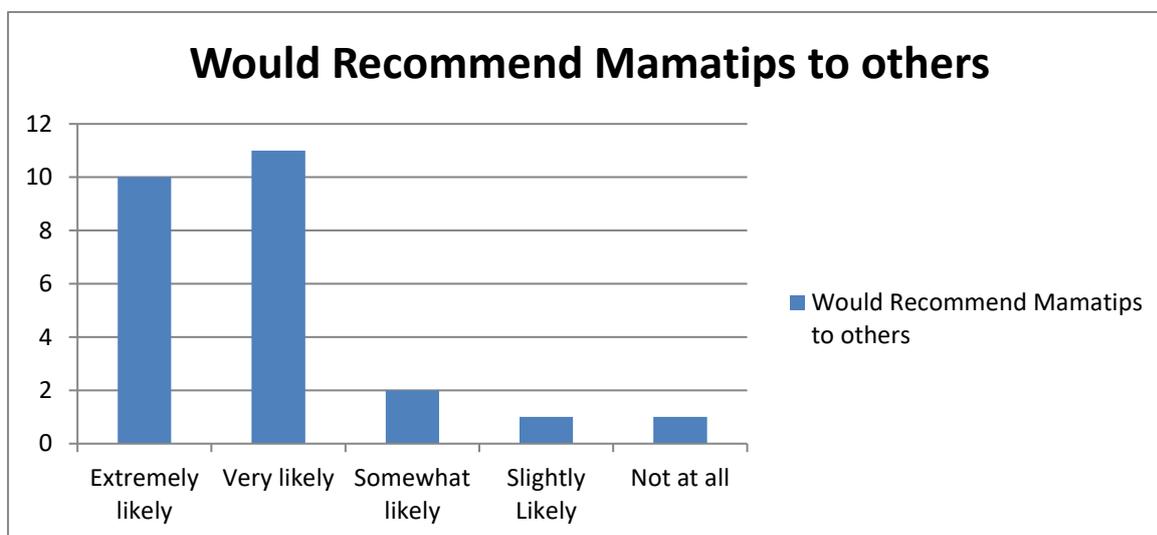
*in a second pregnancy*

Particulars	Numbers	Percentages
Would enroll Again During Next Pregnancy	34	95
Would not enroll Again During Next Pregnancy	2	5



We would encourage mothers to enroll to the service even if it is not their first pregnancy, because each pregnancy is different and comes with its own ups and downs.

*The table below shows the Percentage of women that would recommend the service to others*

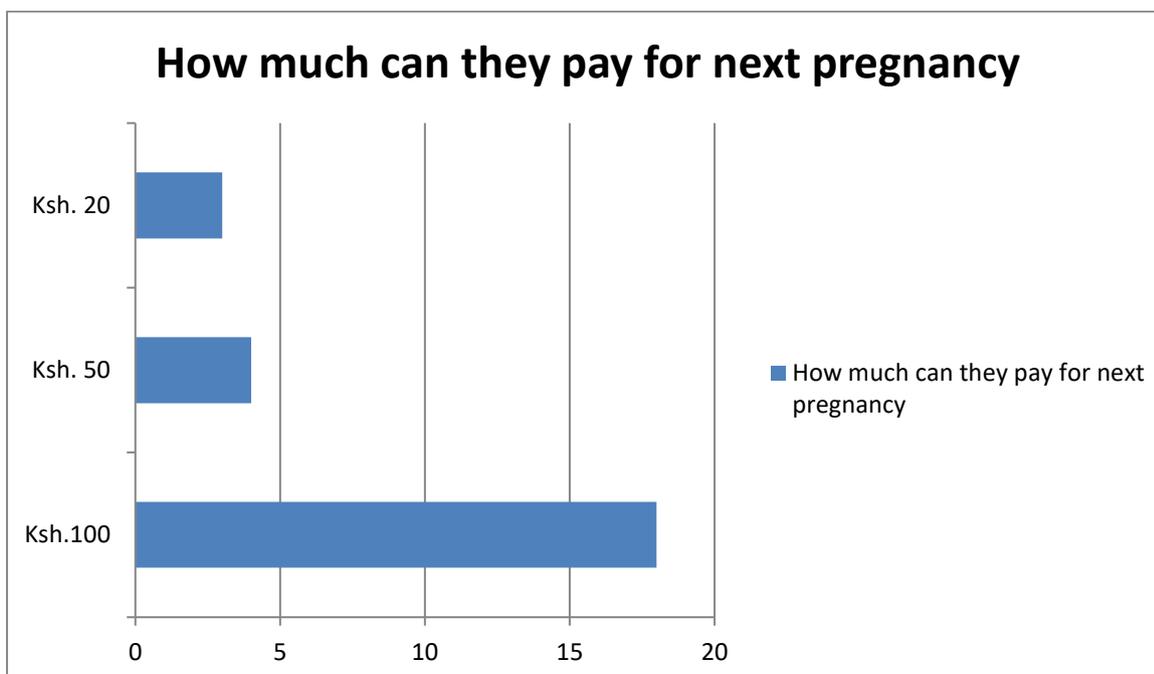
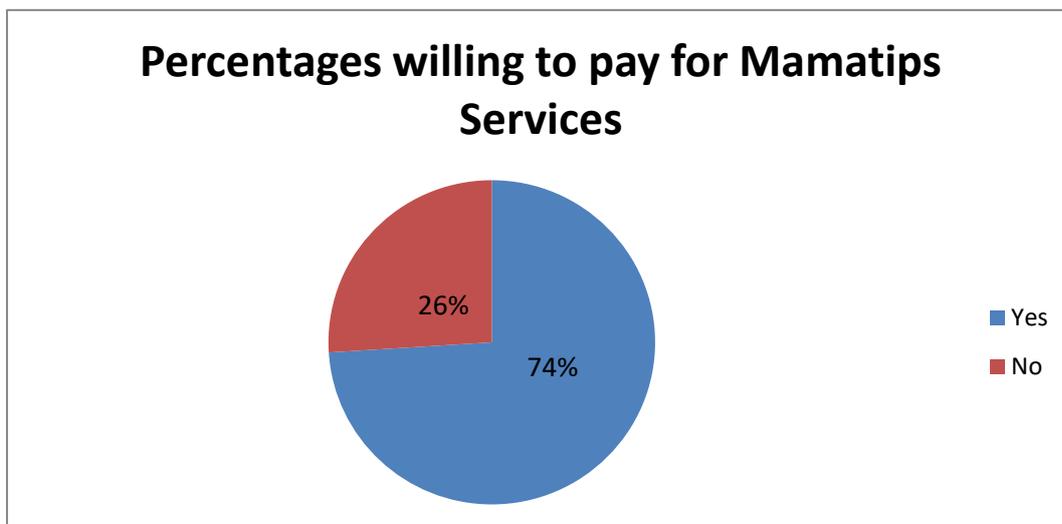


Both the high percentages that would re-enroll into the service and would recommend the service to others shows that the mothers did indeed find the service helpful.

*The table below shows the Percentage of women who are willing and able to pay for the service*

Particulars	Numbers	Percentages
-------------	---------	-------------

Would Pay for Mamatips Services	27	74
Would not Pay for Mamatips Services	9	26



The average amount that the women are willing to pay is Ksh. 86 (0.86 USD). While this would be enough to sustain a shared short code plan with echo mobile, it would not allow for two-way communication, so mothers would not be able to send messages or ask questions to MamaTips.

The table below shows the *Number of women who received messages in the language chosen at enrollment*

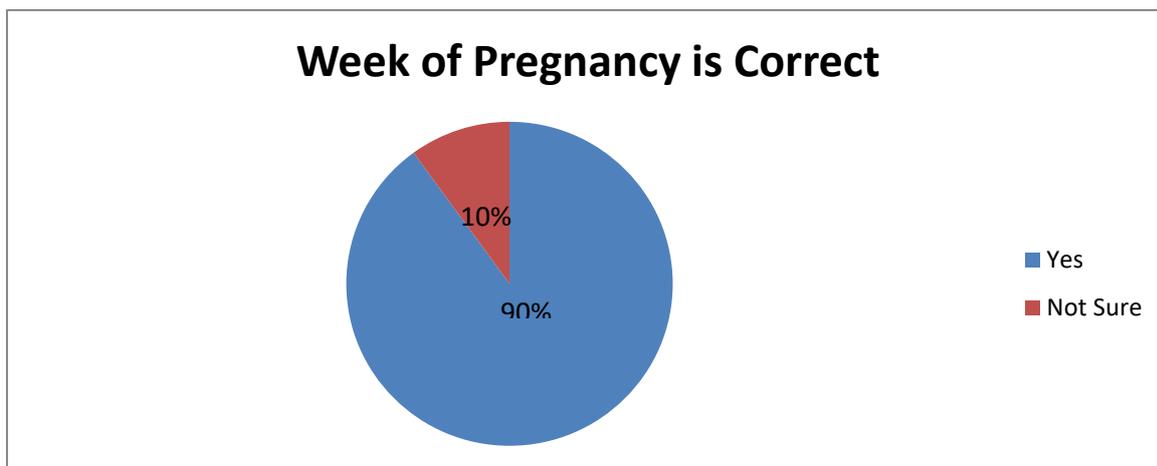
Particulars	Numbers	Percentages
Language was correct	36	100
Language was Not correct	0	0



All women reported that the messages sent to them were indeed in the language chosen at enrollment (English or Swahili).

*The table below shows the Number of women whose messages were correctly aligned to their gestation stage (week of pregnancy)*

Particulars	Numbers	Percentages
Week of Pregnancy was correct	32	90
Week of pregnancy was not correct	4	10

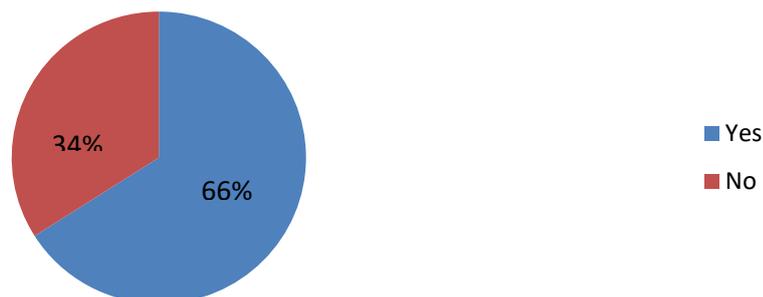


Due to a limit in the number of characters that can be contained in a single text message (160), the week of pregnancy is not explicitly stated in the text messages, which explains why some of the women were unsure. This should not be a problem with voice calls as the week of pregnancy is explicitly stated at the beginning of every message.

*The table below shows the Number of women who received all the three messages from MamaTips each week*

Particulars	Numbers	Percentages
Received 3 Text messages	24	66
Did not Receive 3 Text messages	12	34

### Received 3 Messages each week

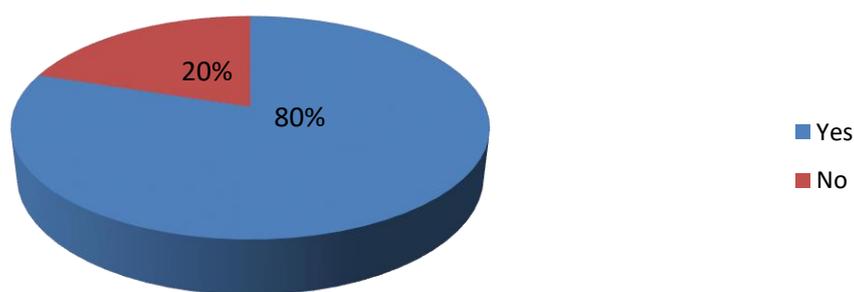


Problems were encountered with the echo mobile platform where, once we increased the number of people enrolled to above 20; the platform as was set then could not be able to handle the large volume of messages being sent out at once. Some women received more than three messages in a week, while others received less. The support team at echo mobile suggested changes which, once effected eliminated the aforementioned problem.

*The table below shows the Number of women who received messages at the agreed times during enrollment (Saturday 6 PM, Sunday 3 PM and Sunday 6 PM)*

Particulars	Numbers	Percentages
Received 3 Text messages at scheduled time	29	80
Did not Receive 3 Text messages at scheduled times	7	20

### Messages Received at scheduled time



The discrepancy here is due to the aforementioned problem with the echo mobile platform, which was later solved.

### Conclusion

Mamatips Project pilot study findings gives us future hope that it is possible to use such platform to ensure pregnant mothers understands what is happening in their pregnancy lives as well as to ensure that they have safe delivery. The higher percentage of 74% willing to pay marks it as enterprise point. The 90% of the enrolled mothers' willingness to re-enroll is a good sign that the pilot study shows future for such project. 36 enrolled mothers were reached by text

messages at a cost of roughly USD 2000; this was in absentia of human resource that was free and voluntarily. If the same project pilot study is to be done by voice messages then roughly USD 1560. For a project that is meant to meet payment of human resources to send text messages and Voice messages approximately USD 8940 is to be used for about 200 enrolled women, some in voice and other texts messages. This also would include translating the content into local languages. Say Somali speakers where an average of 200 pregnant women can be reached, the cost would be fair and worthwhile depending with the coverage and the need of that area. It is practically ideal to state that Mamatips program has secondary effects as the text messages can be sent to the second person and in a manageable cost, the number of characters were limited to 160 which the Safaricom cost of sending was as low as Ksh 2. The total messages for each enrolled mothers were 72 texts that if sent to one secondary recipient would cost each mother Ksh 144 for 6 months. Therefore, a total of 126 texts (42 weeks), 3 texts each week will cost around Ksh 252 for a single secondary recipient which is a reasonable cost.

Through some of the responses received when the enrolled mothers were asked for additional comments it was clear that they had trusted the service offered, some of many comment they gave included; Keep it up, Try to reach all pregnant women coz the programme is very helpful, Can you translate the same information in local languages? Not really coz I'm satisfied, Send a more comprehensive text, "*Muendelelee kuelimisha wamama*" (translates to Continue educating women), Wish their messages were more detailed.

As a learning lesson, it is clear that Mamatips cheap preventive measures for danger signs during pregnancy as well as away to detect early signs of complications that has led to maternal and neonatal mortality. Though the cohort was not in a uniform gestational weeks, those that delivered in the period of the study did not stop the texts messages, reason could be they did not find the study being a bother to them.

### **Recommendations**

MamaTips explored various avenues for expansion, dependent on availability of funds including, but not limited to:

- Further customization of messages- we have a further 3 years' worth of messages covering the period from delivery up to when the child is 3 years. Multiple women from the pilot program, particularly first-time mothers, requested for messages to help them raise their babies. We also have messages specific to pregnant women who are HIV-positive, and thus require extra care. We received a few requests from mothers to send them messages on new born babies. While we have these messages given to us by MAMA, they have not yet been reviewed by medical professionals nor customized to the Kenyan setting yet. This provides a good opportunity for expansion.

- Receiving the messages via text (basic SMS) or as a pre-recorded voice message- while text messages are a more convenient method of communication, a majority of the women in rural places are illiterate. Voice calls are also proved to yield higher retention rates.
- Accountability Partners- The mothers will have the option of choosing someone they trust, such as their spouse, sister, friend or mother, to enroll in our service so that they may be receiving the same messages as the mother and act as an accountability partner.
- Expansion to needier areas- the Kijabe Hospital has connections that would facilitate smooth implementation in the following counties: Garissa, Nyandarua, Nakuru, Kiambu, Nairobi (Dandora and Penda Health) -
- Translation of the messages into more vernacular languages- our priority target vernacular language for expansion is Somali. This would allow us to spread the service to the North-Eastern area of Kenya, where the service is most needed given the high maternal mortality rate.
- Flexibility in call/text times- a woman gets to choose the day and time when she would want to receive the messages/calls. This is particularly helpful in households where only one member of the family, the husband for example, has a phone.
- Incorporation of Medic Mobile- to facilitate communication between nurses at the health clinic in the hospital, community health workers on the field and the mothers, we will be using a software toolkit developed by Medic Mobile (an mHealth company based in San Francisco with offices in Nairobi) that is specifically designed for the provision of maternal health services in low resource settings. It runs offline (internet connection will not be an issue) and allows direct communication between the nurse's computer, a community health worker's phone (where they are available), and the pregnant mother's phone. Through this platform, mothers will get reminders from the clinic for when they are supposed to go for an antenatal care visit. The community health workers get the same notification, allowing them to follow up with the mothers to ensure they attend these visits.

By integrating the Medic Mobile platform into MamaTips, and by including the accountability partners, we will not only be equipping mothers with information to safeguard their health and that of their unborn baby, but will also provide them with the necessary support system to see them through their pregnancy.

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<https://www.youtube.com/watch?v=HAGrEtVe9YE>

<https://www.youtube.com/watch?v=T5NepnL8vFA>

# **An Assessment of Factors Influencing executive Apartment Prices in Nairobi Metropolitan Area of Kenya**

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## **ABSTRACT**

The objective of this study was to establish the factors that significantly influence executive apartment prices in Nairobi metropolitan area which includes parts some surrounding counties like Kiambu, Machakos and Kajiado. The factors studied related to attributes of the executive apartments including: proximity to shopping malls, proximity to Nairobi's central business district, proximity to schools, proximity to slums, presence of swimming pool, presence of balcony, size of apartment, periodic rental income and land value. Both secondary and primary data sources were employed in the research and 30 executive apartments were selected as the study sample. Multiple regression analysis was employed for the secondary data and the findings indicated that size of the apartment, periodic rental income and land value where the apartment is located had significant influence on the price of the apartment. Descriptive statistical analysis was employed for primary data and the findings were consistent with those of secondary data in as far as the determinants of size of the apartment, periodic rental income and land value are concerned which were that the 3 attributes had significant influence on the price of the apartment.

Key words: executive apartments, apartment attributes,

## **BACKGROUND OF THE STUDY**

In the real estate market the value of a property composed of the property's price or rent income. Similar to any market, economist will define the price or rent of a property as being influenced by the forces of demand and supply and the interaction of these two factors in the market. As a result, the price at which buyers or tenants are willing to purchase or rent a property and the price at which sellers or landlords are willing to sell or rent the same property is defined as the value of that property (Brueggeman and Fisher, 2011).

In Nairobi County living in estate apartments is a growing concept in the real estate market which is attributable to the householders demand for housing with unique amenities in addition to placing importance on security (Kenya Bankers Association, 2016). The developers and real estate agents are keen to portray the benefits of estate apartments in order for home buyers and tenants be willing to pay a premium for such benefits which include security and socialization

benefits: (Muiga and Rukwaro, 2016).

Both the public and the government is concerned about the rising housing prices in Nairobi and efforts have been made to build low cost housing for majority of the residents of the city who cannot afford the current houses on offer (Kenya Bankers Association, 2016). Limited land and a growing population in Nairobi triggered by rural to urban migration has caused many Nairobi residents to demand apartments which happen to be within estates and offer security and common amenities including cleaning services (Muiga and Rukwaro, 2016).

### **Research Objective**

To assess factors influencing executive apartments prices in Nairobi County

### **Research Hypothesis**

*H<sub>0</sub>: There is no significant relationship between each of the factors and prices of executive apartments in Nairobi metropolitan area*

### **Literature Review**

Numerous studies have been done and have provided mixed findings regarding the determinants of housing prices. Candas, Kalkan and Yomralioglu, (2015) carried out a study in Istanbul Turkey and examined the determinants of house prices in and employed location attributes, presence of elevators, the floor in case of apartments, heating systems, land value and rent income value. The study used 116 valuation reports and employed multiple regression analysis data analysis method and established that the floor the apartment was located alongside the presence of heating system, the land value and rent value had significant influence on the price of the house. The focus of the current study would be to compare whether the significant determinants of housing prices in other regions of the world like Turkey would also be applicable in Nairobi.

Chung, (2012) studied the determinants of residential property prices in Hong Kong using a cointegration analysis approach. The study focused on house sizes that ranged from very small of below 40M<sup>2</sup> to the very large size of above 160M<sup>2</sup>. The study established that average annual rent income, excess liquidity, Hong Kong stock market index, real interest rates significantly influenced average price of residential houses. The study focused on macroeconomic determinants unlike the study by Candas, Kalkan and Yomralioglu, (2015); Amenyah and Afenyi, (2013); Aluko, (2011). Chung. (2012) study also differs from the current which focuses on housing attributes as the determinants of apartment prices in Nairobi Metropolitan area. From the above two studies the first research hypothesis was developed as follows:

*H<sub>1</sub>: There is a significant relationship between the prices of executive apartments in Nairobi*

*metropolitan area and their related sizes, land value and rental income value*

Amenyah and Afenyi, (2013) carried out a study in Accra Ghana on factors determining residential rental prices. The involved 100 households and it employed the Chi-square technique to assess the association between determinants and house prices in Accra. The findings were that location, size of the house, connection to utility facilities appeared to have significant influence on house rent prices. The study focused on low cost housing units and had determinants relating to connection to utilities unlike the current research which focuses on determinants of pricing of executive apartments in Nairobi where connection to utilities would automatically be in place. From this research the second hypothesis was developed as follows:

*H<sub>2</sub>: There is a significant relationship between the prices of executive apartments in Nairobi metropolitan area and their related location attributes including proximity to shopping malls, schools, slum and Nairobi CBD areas*

Aluko, (2011) studied the effects of location and neighborhood attributes on housing values in metropolitan Lagos. Locational attributes included: proximity to workplace, schools, shopping, recreation and worship centers. Neighborhood attributes included: crime levels, noise levels and the cost of refuse collection. Structural attributes included: area of land occupied by building, number of rooms in the house, number of persons per house, number of kitchens, bathrooms and open spaces per house. Multiple regression analysis was employed and the study found that neighborhood and locational attributes significantly influence on house values when small housing units were examined. From this research a hypothesis was developed as follows:

*H<sub>3</sub>: There is a significant relationship between the prices of executive apartments in Nairobi metropolitan area and the structural attributes of apartment including their presence of a balcony and swimming pool*

## RESEARCH METHODOLOGY

### Research Design

Cross sectional quantitative and descriptive research designs were employed in this research where the quantitative design was to cater for the secondary data that was quantitative in nature while the descriptive design was to cater for the primary data that was in the form of a questionnaire.

### Population and Sampling

There is no official list of apartments in Nairobi metropolitan area and hence 30 residential estates that contain 3 bed-roomed apartments were selected for the research as indicated in Appendix 2.

## Data Collection

**Secondary data was drawn from the internet websites that indicated sale or rent of the 30 residential apartments as indicated in appendix 2. Primary data in the form of 150 self-administered 3 point likert scale closed ended questionnaire was administered to residents of the 30 residential apartments to the residents using convenient sampling technique.**

## Data Analysis

Data was analyzed by employing a multiple regression analysis model where the dependent variable was apartment price while the independent variables included: proximity to shopping malls, proximity to Nairobi's central business district, proximity to schools, proximity to slums, presence of swimming pool, presence of balcony, size of apartment, periodic rental income and land value.

The

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + e$$

Where:

Y = Apartment's price (Kenya shillings)

X<sub>1</sub> = Proximity to shopping malls (kilometers)

X<sub>2</sub> = Proximity to Nairobi's central business district - CBD (kilometers)

X<sub>3</sub> = Proximity to schools (kilometers)

X<sub>4</sub> = Proximity to slums (kilometers)

X<sub>5</sub> = Presence of swimming pool (dummy variables 0/1)

X<sub>6</sub> = Presence of balcony (dummy variables 0/1)

X<sub>7</sub> = Size of apartment - Floor area (dummy variables square meters)

X<sub>8</sub> = Periodic rental income or value (monthly)

X<sub>9</sub> = Land value (Kenya Shillings)

e = error term

β = coefficients

β<sub>0</sub> = constant

## **SECONDARY RESEARCH FINDINGS**

### **Normality Test Results**

According to the one sample Kolmogorov-Smirnov normality test, the variables of the research were generally normally distributed as depicted in Table 1 which implied that parametric tests could be carried out in the data relating to the research.

**Table 1: Normality Test Results**

	N	Normal Parameters <sup>a,b</sup>		Most Extreme Differences			Kolmogorov-Smirnov Z	Asymp. Sig. (2-tailed)	a. Test distribution is Normal.
		Mean	Std. Deviation	Absolute	Positive	Negative			
price	30	14398.33	15242.887	.291	.281	-.291	1.593	.013	
malls	30	3.2267	2.39049	.204	.204	-.142	1.120	.163	
NBI_CBD	30	13.7967	9.87971	.166	.158	-.166	.908	.382	
schools	30	2.3233	1.60166	.280	.280	-.138	1.534	.018	
slums	30	5.3567	3.26134	.128	.128	-.091	.701	.710	
pool	30	.1333	.34575	.517	.517	-.350	2.831	.000	
balcony	30	.6667	.47946	.423	.251	-.423	2.318	.000	
landscaping	30	1.0000	.0000 <sup>c</sup>						
floor_area	30	132.4333	30.73994	.157	.157	-.112	.860	.450	
rental_income	30	56.3000	37.48301	.214	.214	-.202	1.171	.129	
land_value	30	83216.67	120850.663	.344	.344	-.264	1.884	.002	

The adjusted R – square results indicated that the determinants could explain 91.6% of the movement in apartment property prices while 8.4% of the movement could be explained by other factors as per Table 2.

**Table 2: R –Square Results**

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.971 <sup>a</sup>	<b>.942</b>	<b>.916</b>	4411.99990
a. Predictors: (Constant), land_value, malls, balcony, schools, slums, NBI_CBD, size, pool, rent_month				

The findings on joint influence of the determinants on the dependent variable property price indicated that the independent variables were jointly significantly influential on the property price as per Table 3 with p-value being 0.000 which was less than 0.05 at 95% level of significance.

**Table 3: ANOVA Results**

ANOVA <sup>a</sup>					
Model	Sum of Squares	df	Mean Square	F	Sig.

1	Regression	6348707555.169	9	705411950.574	36.239	<b>.000<sup>b</sup></b>
	Residual	389314861.498	20	19465743.075		
	Total	6738022416.667	29			
a. Dependent Variable: price						
b. Predictors: (Constant), land_value, malls, balcony, schools, slums, NBI_CBD, size, pool, rent_month						

The multiple regression results indicated that size in terms of floor area, monthly rent and land value had a significant influence on prices of executive apartments with p-value being 0.051, 0.000 and 0.012 respectively which was less than 0.05 at 95% level of significance as per Table 4.

### Implications of Regression Analysis Findings on Hypotheses

Based on these findings, the first null hypothesis  $H_{01}$ : *There is no significant relationship between the prices of executive apartments in Nairobi metropolitan area and their related sizes, land value and rental income value*, was rejected. While the 2<sup>nd</sup> and 3<sup>rd</sup> null hypotheses  $H_{02}$ : *There is no significant relationship between the prices of executive apartments in Nairobi metropolitan area and their related location attributes including proximity to shopping malls, schools, slum and Nairobi CBD areas* and  $H_{03}$ : *There no significant relationship between the prices of executive apartments in Nairobi metropolitan area and the structural attributes of apartment including their presence of a balcony and swimming pool* were both not rejected as per Table 4.

**Table 4: Regression Analysis Results**

Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-7990.214	6276.409		-1.273	.218
	Proximity to shopping malls	-122.944	376.016	-.019	-.327	.747
	Proximity to Nairobi CBD	179.586	110.538	.116	1.625	.120
	Proximity to schools	-565.262	582.770	-.059	-.970	.344
	Proximity to slums	374.209	309.352	.080	1.210	.241
	Presence of	-4140.616	3697.205	-.094	-1.120	.276

swimming pool					
Presence of balcony	-704.273	2158.447	-.022	-.326	.748
Size (floor area)	-33.924	41.676	-.068	-.814	<b>.051</b>
Rent /month	442.133	44.182	1.087	10.007	<b>.000</b>
Land value	.003	.010	.023	.295	<b>.012</b>
a. Dependent variable: price					

## PRIMARY DATA RESEARCH FINDINGS

### Response Rate and Characteristics of the Respondents

Out of the 200 questionnaires distributed to residents of executive apartments being studied, 122 were filled which constituted 61% response rate. The characteristics of the respondents were as follows: in terms of gender of the residents of the apartments 42% of the respondents were male and 58% were female. In terms of the number of occupants per apartment 19% have 1 to 2 occupants, 58% of have 3 to 5 occupants, 21% of the have 6 to 8 occupants, and only 2% have more than 8 occupants.

### Resident Perspectives on the factors influencing Apartment Prices in Nairobi

According to the residents of sampled apartments using a 3 point likert scale all the factors had significant influence except for proximity to slum areas and presence of balcony in the apartments. The size in terms of floor area of had the most influence on the apartment pricing.

**Table 4: Resident Perspectives on the factors influencing Apartment Prices in Nairobi**

S/N	House Attributes	Average Rating (out of 3)	Degree of influence on Apartment Prices
1	Proximity to Nairobi CBD	2.4	Significant
2	Proximity to schools	2	Significant
3	Proximity to shopping malls	2.4	Significant
4	Proximity to slum areas	1.9	Not Significant
5	Presence of swimming pool	2	Significant
6	Presence of balcony	1.8	Not Significant
7	Size of housing	2.8	Very Significant
8	Landscaping	2.4	Significant

9	Rental income	2.5	Significant
10	Land value	2.5	Significant

### Triangulation of Findings from Primary and Secondary Data Sources

The findings of secondary and primary data analysis were triangulated and the results were that 5 out of 10 determinants had consistent effect on the apartment prices in Nairobi metropolitan area while the remaining 5 out of 10 had inconsistent effect. Two of the determinants had consistent insignificant effect including: proximity of slum areas, presence of balcony. Three of the determinants had consistent significant effect on apartment prices including: size of the apartment, land value where the apartment is located and the rental value of the apartment as indicated in Table 5.

**Table 5: Triangulation of Findings from Primary and Secondary Data Sources**

S/N	Apartment Attributes	Secondary data findings on determinants of apartment prices in Nairobi	Primary data findings on determinants of apartment prices in Nairobi	Consistency between secondary and primary data findings
1	Proximity to Nairobi CBD	Not Significant	Significant	Inconsistent
2	Proximity to Schools	Not Significant	Significant	Inconsistent
3	Proximity to Shopping Mall	Not Significant	Significant	Inconsistent
4	Proximity to Slum Dwelling	Not Significant	Not Significant	Consistent
5	Presence of swimming pool	Not Significant	Significant	Inconsistent
6	Presence of Balcony	Not Significant	Not Significant	Consistent
7	Size of housing	Significant	Significant	Consistent

8	Landscaping	Not significant	Significant	Inconsistent
9	Rental income	Significant	Significant	Consistent
10	Land value	Significant	Significant	Consistent

## DISCUSSIONS

From the findings of the current research, the determinants that have significant influence on apartment price include size of the apartment, the rental value and land value where the apartment is built. These findings are consistent with those of Candas, Kalkan and Yomralioglu, (2015) who found that these 3 factors had significant influence on house prices in Turkey.

## RECOMMENDATIONS

Stakeholders interested in establishing the prices of executive apartments in the Nairobi metropolitan area should focus on the 3 key influential factors of size of the apartment, its rental income value and land value on which the apartment is built.

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### APPENDIX 1: SAMPLE QUESTIONNAIRE

1. Name of the executive apartment you reside in?: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

2. Your name (optional): \_\_\_\_\_

3. Your **gender**

Male

Female

4. Number of people live in the house? Please tick and state the **number**

1-2

3-5

6-8

More than 8

5. To what extent do you think the following attributes influenced the price of the apartment you reside in? (please tick appropriately)

<i>S/N</i>	<i>Apartment Attribute</i>	<i>(1) No influence on apartment price</i>	<i>(2) Moderate Influence on apartment price</i>	<i>(3) Great influence on apartment price</i>
1	Proximity to Nairobi CBD			
2	Proximity to Schools			
3	Proximity to Shopping Mall			
4	Proximity to Slum Dwelling			
5	Presence of swimming pool			
6	Presence of Balcony			
7	Size of housing			
8	Landscaping			
9	Rental income			

10	Land value			
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## APPENDIX 2: SAMPLE RESIDENTIAL APARTMENTS

S/N	Residential Estate	Area of Nairobi Metropolitan
1	Greatwall Phase 3	Syokimau
2	Bamboo Upper Hill	Upperhill
3	Jannah Estate	Eastleigh
4	High End	Westlands
5	Loresho Apartments	Loresho
6	Jacaranda Githurai 44	Kamiti
7	Nyayo Estate	Embakasi
8	Nula Apartments	Langata
9	Ridgeways Lamuli	Ridgeways
10	Kileleshwa NHC	Kileleshwa
11	NHC Nbi West	Nbi West
12	ImaraDaima Apartments	ImaraDaima
13	Blue Bells Apartments	Syokimau
14	Tamarind	Utawala
15	Eureka Apartments	Woodley
16	EduLink	Ngong Road
17	Komarock	Komaroc
18	Bogani Apartments	Karen
19	Flame Tree Apartments	Thika
20	Wangige Apartments	Wangige
21	Ruaka Heights	Ruaka
22	Riruta Apartments	Riruta
23	Kitenge;A Apartments	Kitengela
24	Joska Apartments	Kamulu
25	Rongai Apartments	OngataRongai
26	NHC Madaraka	Madaraka
27	Buru Buru Apartments	Buru Buru
28	Ngumo Apartments	Ngumo
29	South C Apartments	South C
30	South B Apartments	South B

## **Secrets to Success in informal Sector Financial Compliance: Utilizing new Technological application for Improved Community Health Program Efficiency and Effectiveness**

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### **ABSTRACT**

Secrets to success in informal sector financial compliance: Utilizing new technological applications for improved community health program efficiency and effectiveness  
Financial compliance is an essential aspect of good project management. Most organizations function inside the formal economy for [funds disbursement](#) . However, frequently community health activities involve the lowest economic sector consequently working outside the formal economy. Substantial effort to maintain donor related financial compliance exposes staff to individual security risks, loss of resources, cumbersome financial reconciliation, risk of fraud and corrupt procurement procedures. New products in mobile money platforms, recently developed to address needs of businesses operating in the informal sector are available. AIC KIJABE [Maternal Newborn Community Health Program](#) adapted a mobile money platform of funds. We customized its protocols to develop best practice for improved compliance in informal sector of community health work to meet needs for transport reimbursements and informal sector catering services. It includes a real-time payment and receipting, combined with an online budgeting for staff which radically improved field work efficiency, reduced financial risks, eliminated carrying hard cash for payments and reduced accounting work effort. Adoption of the new system began in June 2017. The pilot demonstrated reduction in staff hours required for cash procurement, distribution, and accounting from 4 hours to 1 hour for a similar field activity. Additionally, a reduction of multiple trips to one trip by the project vehicle to follow institutional procedures eliminated staff time and saved Ksh6200 on mileage costs. Total estimate savings in terms of hours of productivity for staff deployed reduced effectively, from 4 staff per activity to 2 staff. Improved compliance was noted by our grant management service and adopted across range of their programs in their national scope and they are assessing for a multi-country application of the same in their other programs.

### **Introduction and Background of the Study**

Financial compliance is an essential aspect of good project management. Financial compliance rules are increasing and regulations are increasingly difficult and time consuming to administer. Yet financial compliance at the highest level is essential for donor management. Management of finances to ensure value for money is also a part in good donor relations. The importance of financial compliances requires a verification

process that tracks all the transactions. The tracking is supposed to verify that the amount was paid, to whom it was paid, the date, time of the payment and written confirmation of receipt by the recipient. Consequently, showing evidence that the transaction took place in the first place. Reconciliation is an important tool in financial management it enables reconciliation of the cash book, the bank, and field activities this brings synchrony of the projected budget and the actual budget. Another fundamental compliance is that of the programs and partners financial policy and procedures.

Programs work in formal sectors where financial accountability is governed by both national and international regulation. These regulations provide a safety net for donors who require transparency and accountability to demonstrate value for money in achieving their objective. In order to achieve United Nations sustainable development goals (SDGs) universal healthcare access, it is essential to work at the community level in primary healthcare with an emphasis in health prevention and promotion. This is particularly important in addressing maternal and child health. Community health workers are the front line of service delivery in increasing demand for and utilization of primary healthcare services. Community Health Workers (CHW'S) work predominantly in the informal sector and the standard way of doing business in the informal sector is cash. This was necessary for community health field activities for routine reimbursements of people who were volunteers and at the lowest level of the economic sector.

Mobile money is safer than all handling cash in the informal sector. Risks of cash based systems face challenges in tracking direct utilization of funds which is usually paper based and exposes programs to individual staff risks ranging from theft to Fraud to physical harm. The challenges of the cash base system range from; with finding correct change of small amounts for transport reimbursement, to more efficient verification of payments, participation verification, date and frequency. According to Kikulwe, Fischer and Qaim (2014) this platform facilitates transfer between business partners and reducing transaction costs.

In 2007, Safaricom, launched a mobile money program called M-Pesa (Ekim, 2014). This platform has gone through a many iterative cycles in meeting customer needs and wants. The direct bulk disbursement product introduced to the market was aimed at sending money from a business to a customer. This is a structured payment plan that is used to pay daily wages, dividends and insurance. It cuts off the manual process because it is done online and it issues receipts. It was developed to cater for merchants who want to pay a large group of people who are predetermined (Safaricom, 2018). This system is

not ideal for unstructured payment for people who are not predetermined.

Adaption of using mobile money systems in developing countries like Kenya with the aim of including the informal sector is on the rise. “Mobile money services are being deployed rapidly across emerging markets as a key tool to further the goal of financial inclusion. Financial inclusion, the development of novel methods to enable individuals at the base of the pyramid to access formal financial services and become part of the formal financial system, is considered a key pre-requisite for lifting these populations out of poverty and for driving economic growth” (Lal and Sadchev, 2015, p3). They stated that the advances money services offered range from money transfers, savings and more recently loans.

According to the Communication Authority of Kenya (2018) growth of mobile money platforms has attracted major investors into the trade bring about regulations to enhance fair trade. The rise of competition in mobile telecommunication has introduced “porting” as a way of merging all the mobile service providers where the customers will not be exploited. Furthermore, in the effort of protecting the interest of the customers, the users will not be restricted to one mobile service contractor. The Kenyan government has established an enabling environment hence more people are subscribing to mobile telephony. These advances in technology and costs of utilizing mobile money have meant that these services have penetrated the lowest economic sectors (where CHWs function). Additionally, the advances in services provided by mobile money platforms include line item tracking and statements. Similarly, the growth has led to an increase in the customer base (Etim, 2014). Mobile money platform has been used as a means to achieve financial compliance in the informal sector; for accountability, budgeting, reconciliation, reporting and timelines.

#### Kijabe Hospital Maternal Newborn Community Health Program

AIC Kijabe Hospital (2017) Kijabe Hospital (KH) is a Faith based organization that has been offering health care services for over one century. It functions on the formal economy as is expected by other related types of organizations. According to a World Bank blog of Dasgupta (2016), many people work in the informal sector as an obligation and not by choice. Maternal Newborn Community Health (MNCH) program operates in the informal sector. The program works outside hospital walls and functions at a lower economic subset of the population, forcing the program to work outside the formal economy where there is structure as stated by Funds for NGOs (2018). This has posed a series of compliance challenges and individual risk to staff. Since the program’s inception of ten years ago, Kijabe Hospital Maternal Newborn Community Health

Project has been working with the objective of reaching out to the neighboring communities on preventive healthcare in collaboration with the Ministry of Health (MOH) to achieve national healthcare goals (Measure Evaluation, 2016).

MNCH program reimburses Community Health Volunteers (CHV'S) and Ministry of Health Officials' transport during capacity building activities. In addition, they offer meals during trainings and activities. As a way showing compassion to the participants who take time off their usual activities to spend time being trained as community health volunteers considering that they are not on a pay roll. People at the base of the economic pyramid rarely have sufficient financial margin to finance BOTH the giving of their time and the transport costs involved in volunteer activities. The MNCH training programs run in different sub counties where the volunteer participants commute daily for two weeks of community health strategy training (Ministry of Health [MOH], 2007); basic training and MOH 513, a household health survey or commute daily for Maternal newborn classes which take seven months to complete. The project officers are required to train, organize for meals and reimburse transport to the participants as part of their routine duties.

#### Potential limitations of the mobile money platform

According to the Communication Authority of Kenya (2018), 86.2% of the country has mobile coverage while 28.7 million people access mobile money transfer service subscriptions. Additionally, the report states that there has been an increase of mobile money agents. That notwithstanding, limitation may arise in areas where the participants cannot access network or proximity to Mpesa agents to remove cash. The mobile money is sent from a financial institution which is usually the holder of the money (Lal and Sachdev, 2015). These institutions usually have set working hours and limitations that may cause delays of money transfers.

#### Assumptions of the study

90% the participants have own registered mobile phones and the rest will have a trusted family member who owns one.

- i. Participants have access to mobile money agents.
- ii. Participants live in areas where there is good network coverage.
- iii. The participants will accept to mobile money transfer instead of cash.
- iv. The participants will trust that the MNCH will pay them after one week as opposed to paying them daily.

### **Justifications/rational for the study**

Test replacement of cash payment system with mobile payment system so as to examine both systems for efficiency and effectiveness.

### **Methodology**

The study designed a pre post examination of financial procedures in the setting of informal sector community health field activities; using standard cash based system (pre) and a mobile money platform (post) for field activity reimbursements. We examined staff hours required for budgeting, reconciliation, and reporting. We also examined transport expenses for moving cash to the field activity and banking fees (relevant to the mobile money platform).

Procedure used in acquiring and disbursing of funds using the cash system required that an activity budget be developed and receive approval. A Cash advance was obtained and based on budgeted expenses. When cash released required a separate approval form. Once the director signed; the document was taken to the accounts department then cash was dispensed. The accounts department has a policy that cash payment was not available until 10am, making it necessary that a MNCH staff person stay behind the rest of the team on a given days activities in order to receive money and then travel via public means or a second trip with the project vehicle was required. This meant getting cash to handle field responsibilities required us to pay a nurse or other senior staff person who could be trusted during all the extra time spent to work with cash window hours.

In addition, at times in order to address the timing of cash window, an available staff member would get cash the day before exposing them to additional risk of an extended time where they were responsible for cash. Organisation policy would set financial limits which meant that insufficient cash could be dispensed at one time and so a week advance notice was required for amounts that were routinely required for larger activities. The advance notice allowed the finance department to be certain they had sufficient cash reserves to handle patient related hospital bills

The cash payment system utilized the accounting services of Kijabe Hospital for maintaining accurate records of cash advances, reconciliation of cash that was not spent in the field, general accounts, banking, etc. Given the paper based system and field activities in the informal economy, delays in account reconciliation were inevitable. Thus getting real time account information for forecasting was problematic. Cash payments pose a risk for programs and individual staff, requiring additional attention to detail, working within established norms and hospital policy in order to obtain cash from the

business department in order to carry on normal project related activities. Carrying large amounts of cash poses a threat to individual staff security, receipting issues can be cumbersome in close to the community programs, especially where small reimbursements of workers or volunteers are irregular (as opposed to monthly salary), and the participants are not formally employed.

Procedure for acquiring funds Mobile payment system used development cycle kept being improved to meet customer needs. The program contracted Hospital Support Organization (HSO) to handle online cash transactions for the field activities in June 2017. Fees for HSO grants management services were negotiated at 6% of grant income. However, the advantage of the HSO grants management system was a willingness to work with a mobile money platform. Fees on the mobile money platform were a per transaction amount. The mobile money platform option in Kenya is quite sophisticated. Mobile money transactions is available in leading communication companies, the completion within the companies have made these services attractive. Recent advances in the services offered by the mobile money platforms and collaborations with banks meant opportunity to explore this alternative to the cash based system (Logan, 2017). This mobile money platform system was introduced as a pilot program jointly by MNCHP and HSO as a solution to the challenges faced in the cash system. Neither HSO nor MNCHP had used the program before.

The stages of mobile transfer required an iterative cycle to improve systems for the field staff. During preparation; the project officer is required to send the list of the CHV's and a separate list for the MOH sub-county staff who would be participating in the training. This attendance form is to be filled in on the first day of the training (usually Monday) and confirmation of the list should be done on Wednesday. At the second stage, a field officer would ensure the final list is sent to the project manager by taking a picture and sending it through whatsapp or using a tiny scanner app, he would scan the document and send on email. The list was then sent to HSO and within two hours the participants would receive their payment and sign on the attendance list. In the case of one day events like the Maternal Newborn class, the list would be signed at the beginning of the training. Since HSO will need a notice of at two days, MNCH will avail the budget of the training in advance. The payment would be done while the training is going on and they would sign at the end of the training.

Caterers would be contracted during the preparation stage of the activity; where they would contract and sign an agreement form containing, the date, time, number of people, number of meals, registered mobile number and full identification of

the caterer. Once the proper procurement procedures had been followed, the project officer would share the quotation with the project manager. On receiving this information, the project manager will liaise with HSO and the payment would be done in two installments. This procedure would apply to payments of all services that are not provided by KH. Commercial Bank of Africa(2018) that internet banking can work across all networks for flexibility and efficiency.

The projected would be sent to HSO at least two days in advance to give them ample time for preparation. The department would procure three mobile phones that would be registered to the program officers to serve as petty cash phones. The officer would be required print a self-care statement at the end of every month for reconciliation. The petty cash telephone will be used for MNCH purposes only.

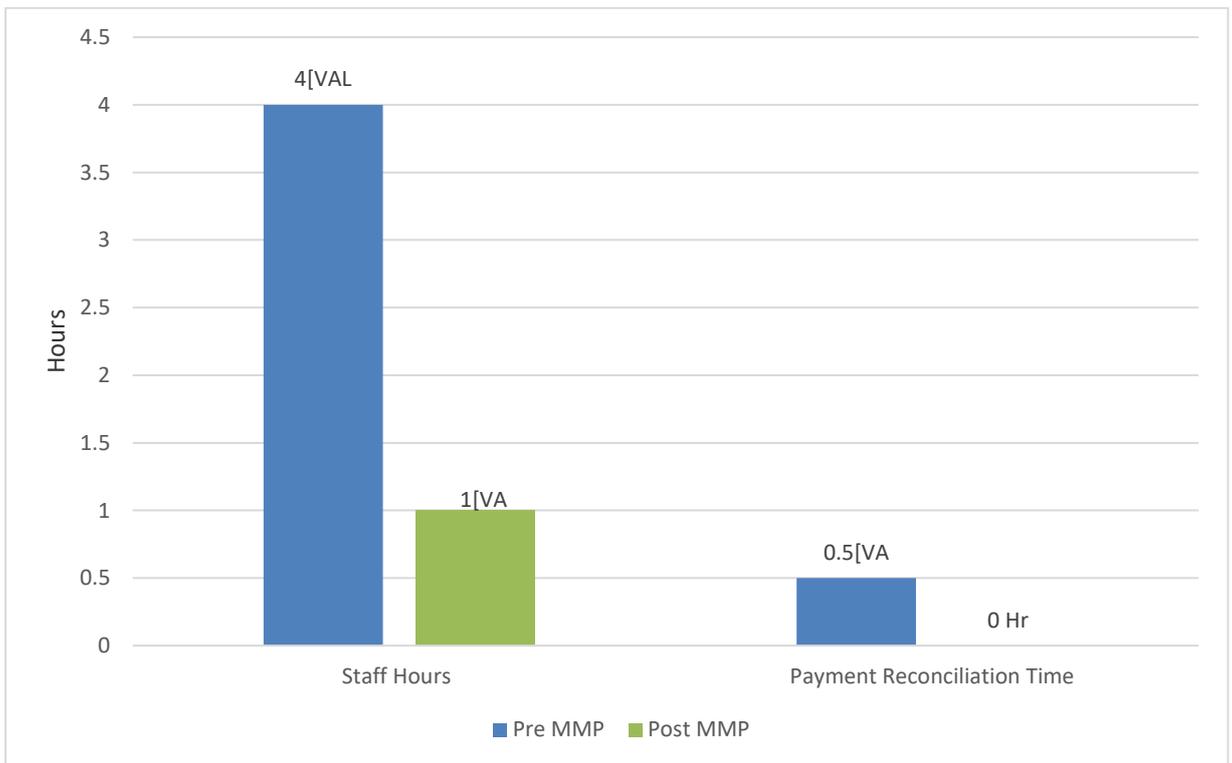
### Results and Discussion

In June 2017 MNCHP embarked on journey to embrace innovation by moving to a mobile remittances payment platform. Whereas the cash system is considered familiar, cheaper with no disbursement fees, the online system is fast, reliable, shows accountability and saves resources. The result will show the similarities of both methods of disbursing funds, the differences and challenges faced.

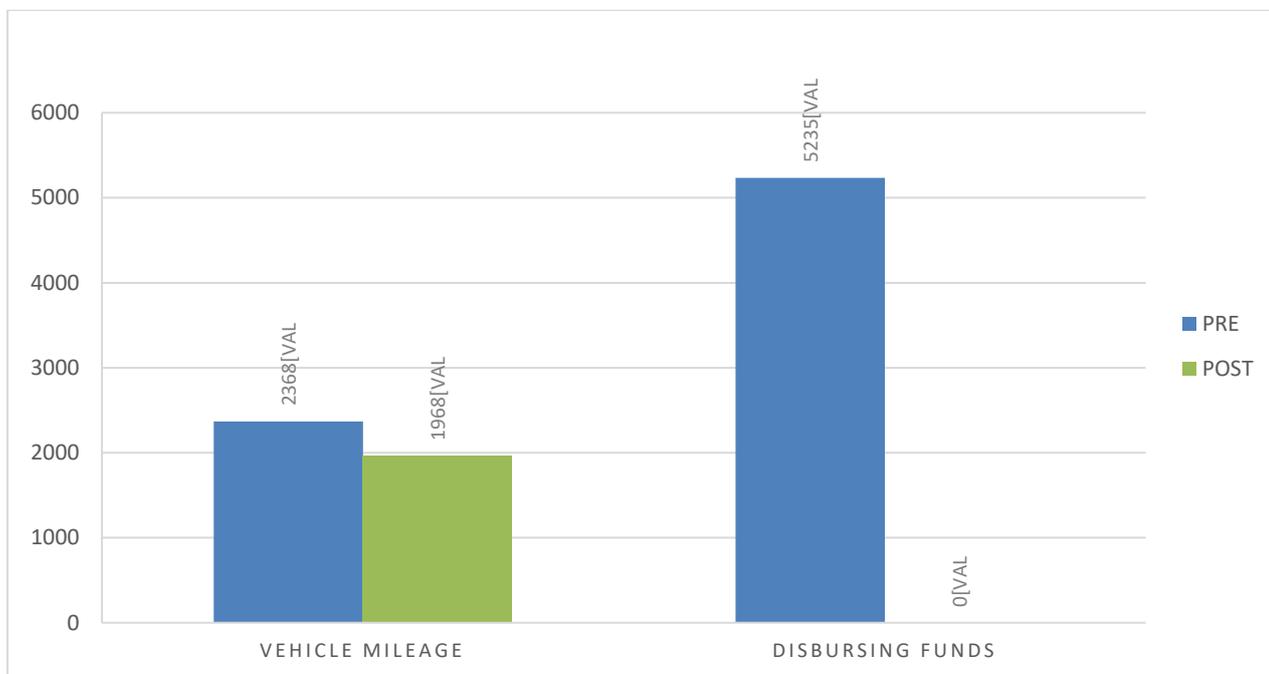
One of the similarities between the mobile money and cash systems is that they both pay the contracted caterer, the CHV's and MOH staff transport reimbursement paid at the end of the activities. Likewise, in both systems the activity budget for catering and transportation reimbursements (i.e. caterer's projected budget and the actual budget remained constant (that is the price the caterer quoted remained the same) as shown in the table below. Additionally, they both have a similar process of authorization for cash to be released, however the mobile money system utilized and electronic authorization process via email so real time activities could be tracked in the field. The cash system was all paper based and required a face to face authorization signature and a cash window disbursement. Both the payment systems exhibited time delays for field activities.

ITEM	FREQUENCY		PERCENTAGE	
	PRE	POST	PRE	POST
Staff hours spent collecting and reimbursing cash during the activities	4 hours	1 hour	75%	25%

Amount of time spent on funds reconciliation after the activities	30mins	0	100%	0
Vehicle mileage during two week long activities	2,368	1,968	83%	17%
The amount of money spent disbursing funds	0	5235	0	100



**Figure 16. Time comparison between pre and post mobile money payment**



**Figure 17. Difference in Vehicle Mileage and Disbursing funds before and after mobile money payment was introduced**

The financial statements from the online platform were received on time whilst the cash payment needed more clarification from the field officer who had to create time to reconcile the finances with the accountant. The project officer was required to spend a **four hours** in the office carrying out reconciliations manually. This is because of the daily paper work on attendance sheets and the daily remittance to the caterer. The time spent on cash reconciliation has been reduced to (1 hour) **25 %** because the field officer does not carry cash. At the end of every month the field officer is required to print out his Mpesa statement and attach it to the petty cash vouchers he disbursed. The time saved on cash reconciliation is (3 hours) **75%** and this is done once a month regardless to the number of activities (Etim, 2014).

Similarly, time has been saved in payment of participants in the field. They are paid in small denominations and accessing loose change was strenuous. The payment is done after the activity in the evening where each day has a separate sheet which would take 30 to 45 minutes. In the Mobile payment, this time has been reduced because remittance is done at the end of the week and one single signing sheet is signed on Friday in the case of a week activity. Consequently, saving time of approximately 30 minutes multiplied by four days (**2hours**) and reducing the stress of long rigorous financial reporting while enabling timely monthly statement to assist in program planning.

The engineering department reported a drop in mileage and fuel costs since this system was rolled out. The field officers do not spend time on the road collecting

cash for the activity. Moreover, the resources like staff time have been used wisely to develop modules that are more efficient. The distance from one community health activity venue is to Kijabe. A return trip to Kijabe exhibited mileage of difference of 17%. Cost per mileage is calculated at Ksh.40 per kilometer for all activities the saving would be. Since the cash was collected three times, it would mean that the program saved money during this activity. Just as stated by Kikulwe et al (2014) that the transaction cost taking money to the rural area is high.

Unlike the cash payment which was free, mobile money payment accrues additional of bank charges Ksh75 per transaction and an additional 27 shillings for Mpesa withdrawal charges. MNCHP accrued a total of Ksh 5235 in bank charges. This was inclusive of all the activities that were held in the same month. Similarly, there were participants who had their mobile numbers registered to different names which the banking system rejected. This caused delays that would not have been experienced in the cash system.

#### Limitations of the study

Study limitations include use of a small sample one program with two similar activities carried out in two different sub- counties over a period of two weeks. More so, the limitations of the study require the participants to have cell phones, registered mobile numbers and identity cards. The bank regulations are another limitation where we are dealing with a specific bank which has specific working hours. Similarly, the Hospital Support Organisation (HSO) has regulations as well; the request for funds would be sent two days in advance so that the main signatories approve cash is disbursed. Finally, the transaction is dependent on the internet connectivity.

In the online platform, the requests are done online and are copied to the authorities in charge. Their physical presence is not needed so no delays have been experienced yet. Apart from an isolated experience where the bank once went offline and delayed sending funds to the field on time; fortunately the funds were needed on the next day hence the activity was not affected. This bank issue was during the election nomination cycle and this has not been experienced again.

In conclusion, the cash system is considered familiar, cheaper with no disbursement fees whilst the online system is fast, reliable, shows accountability and saves resources. The program embraced innovation as a means of scaling high to enjoy efficient and effective financial compliance. The Hospital Support Organisation is looking to use this system with some of the programs that operate in the informal sector.

## Definitions of terms

CHV: Community health Volunteers who work at the primary level of the health care system. They are members of the community who work without pay

CHEW: This is government worker who supervise the CHV's at the health facility level, it could be a nurse or a public health officer.

Formal economy: This is a kind of economy that follows government regulations

Informal sector: This economy that is neither taxed nor followed by the government.

KEPHS: This is a national community health manual that is used to train community volunteers

MNCHP: Maternal Newborn Community Health Program works in partnership with the Ministry of Health to achieve national health objectives.

MOH 513: This is a Ministry of Health household registration tool.

MPESA: Safaricom mobile money transfer platform

Registered mobile: The Kenyan Government requires that one registers their name and identification to all mobile money.

HSO: Health Support Organization is an organisation that offers financial and project management

Maternal Newborn Classes: This is a community health strategy module that is used to train Community Health Volunteers on health indicators of maternal and newborn

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# Advancing a Clean Cookstove Culture in Sub-Saharan Africa: The Transformative Power of *Afrikan*<sup>3</sup>Innovation

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## ABSTRACT

A transition to an energy-efficient, clean and safe cookstove culture among the global energy-poor can reduce mortality, poverty and positively impact the protection of biodiversity and the climate, as identified in the United Nations’ Sustainable Development Goals. Despite broad support, only a limited number of interventions have shown success, at scale, over the long term. The uncertain, complex and dynamic nature of sustainable development programmes is increasingly being recognised. Current design methods appear limited in addressing the inherent complexities of the sustainable integrated design of products, services and systems. Transdisciplinary design methods need to be considered, inculcating an African perspective. In this paper, the applicability of indigenised design approaches in achieving a significant shift to a safe and energy-efficient cookstove culture among energy-poor sub-Saharan households is investigated. The use of innovative transdisciplinary methods, specifically participatory methods embedded in local culture, could contribute significantly to shifting energy-poor sub-Saharan households to a clean and safe cookstove culture. The integration of Africa’s resilient cultural practices could provide individual and collective alternatives to design research methods rooted in Western ontological and epistemological approaches, in transitioning to a sustainable future.

*Keywords: Afrikan Design Innovation, Afrikology, Appropriate Technology, Clean Cookstoves, Design Thinking, Radical Incrementalism, Transformation Design, UN Sustainable Development Goals.*

## INTRODUCTION

Household air pollution (HAP), in large part due to the use of inefficient cookstoves, is the third most significant global cause of morbidity and mortality, primarily affecting women and children (WHO 2014). A transition to an energy-efficient, clean and safe cookstove culture

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<sup>3</sup>The term *Afrikan* in this paper refers to Nabudere (2012) who situates transdisciplinarity within the concept of Afrikology – Afrikology being defined as a “platform for the dissemination and practice of multidisciplinary, interdisciplinary and transdisciplinary research, dedicated to the development and advancement of Afrika and her people”.

among the global energy-poor can reduce mortality, poverty and positively impact the protection of biodiversity and the climate, as identified in the United Nations' Sustainable Development Goals (Yamey et al. 2014).

Despite broad support, only a limited number of interventions have shown success, at scale, over the long term (Hanna et al. 2012; Urmee & Gyamfi 2014). The challenge remains how to significantly increase clean and safe cookstove use within communities, reduce respiratory disease and mortality, protect biodiversity, climate protection (reduced greenhouse gas emissions) and poverty reduction, without on-going external development assistance. The uncertain, complex and dynamic nature of development programmes is increasingly being recognised (Alesina & Dollar 2000; Morrissey 2004; Stokke 2013). The use of development assistance as an extension of soft power traditionally by the West and recently China in sub-Saharan Africa is well established (Ayittey 2015; Nye 2012; Pamment 2015; Zhang et al. 2016). The intention is to portray a narrative of partnership, friendship, sympathy, appeal and influence, and assist the attainment underlying long-term strategic goals (i.e. markets for consumer products or securing natural resources) (Nye 2005; Pamment 2015).

Current design methods are limited when tackling the inherent complexities of the development sphere (Ceschin 2014; Qureshi et al. 2013). Any design-led efforts that address the use of inefficient cookstoves need to inculcate the explicit, implicit and tacit motivations of the various political, social and economic factors. This deeper understanding is often lacking due to the designers originating from a different cultural and socioeconomic backgrounds, leading to remote design solutions parachuted in with little effect (McClelland & Suri 2005; Ramirez 2010).

### Transformation Design

Drawing on the field of *transformation design*, transdisciplinary design approaches are suggested in overcoming the abovementioned complexities and power dynamics (Ceschin 2014; Sangiorgi 2011; Vezzoli et al. 2014). *Transformation design* can be defined as a human-centred, transdisciplinary process to create sustainable changes in human behaviour and their systems and organisations to achieve social cohesion and equity (Burns et al. 2006; Jonas et al. 2015). A key component of *transformation design* practice is a concern with the power of decision making in the participatory design process, with the participant becoming co-creator (Sangiorgi 2011). Central to a transformation in cookstove use is the real empowerment of the cooks (i.e. the local women bearing the largest part of the burden). Transformative clean cooking initiatives could empower women, providing significant opportunities for social and economic empowerment.

## Afrikan Design

An *Afrikan* design approach, informed by Nabudere's concept of Afrikology, is proposed as a transdisciplinary approach during the design process of finding sufficient alignment in values between the different perspectives of stakeholders and beneficiaries. The convergence afforded by an *Afrikan* communitarian worldview provides a window of opportunity during a design process for a radical incrementalist process where the transformative change consists of a series of small changes over time, laying the groundwork for far-reaching large-scale changes, without maintaining the status quo. Nabudere (2012) suggests that in Afrikology, knowledge emerges holistically from a combinatory understanding of seemingly disparate fields (i.e. socio-economics, philosophy, spirituality, governance, technology and science). Nabudere (2012) argues that it is impossible to detach a research problem from its larger context, suggesting a conscious process geared towards collective development, grounded in an African worldview. While Norman and Verganti (2014) believe that a typical human centred design process is better suited to an incremental innovation approach, Ma (2015) suggests that reframing the meaning-making process at the outset of a design process can accommodate the long-term goals associated with a radical transformative approach as found in the fields of social innovation and transformation design,

Ma (2015) asserts that the anthropogenic worldview in most design processes of designing to meet a short-term need through the lens of the desirability, viability and feasibility of a solution, without acknowledging that humans are part of a larger bio-physical, social, and economic infrastructure is the root of the problem. In this sense, a holistic African Design approach can accommodate a radical incrementalist design process is guiding a long-term vision with incremental efforts to respond to, and influence human values and actions towards states of convergence within a variety of spheres.

## Problem Statement

Design research appears to be deeply rooted in Western ontological and epistemological approaches, with designers attempting to bridge cultural differences by modifying existing design strategies, frameworks, methods and techniques to suit different cultural contexts with limited success (Truna et al. 2007; Winschiers-Theophilus & Bidwell 2013). In this regard, designers appear to approach local cultural differences as a collection of attributes associated with specific artefacts rather than an interactive engagement with local cultural practices (Winschiers-Theophilus et al. 2012).

The primary goal of achieving a measurable change in cookstove related practices appears to be subordinated to the design of increasingly efficient stoves. Abdelnour (2015) ascribes this phenomenon in clean cookstove initiatives to a form of *techno-saviourism*, where the

technological object is elevated to the point where it can solve a myriad of complex and interrelated problems, yet neglecting to place the culinary practices of poor women at the centre. Sommer and Welzer (2014) suggest that sustained transformative change cannot be planned either politically or administratively at bureaucratic international conferences – a common feature of sustainability initiatives over the last four decades. Abdelnour (2015), Welzer & Leggewie (2009), Sommer & Welzer (2014) assert that sustained changes in practices do not occur due to the introduction of a superior technology or published scientific findings.

### Research Question

The question arises whether an *Afrikan* design approach could significantly change cookstove-related practices, and help reduce the scourge household air pollution in sub-Saharan Africa.

### Main Research Aim

The aim in this paper is to investigate the applicability of *Afrikan* design approaches in achieving a significant shift to a clean and energy-efficient cookstove-related practices among energy-poor sub-Saharan households.

### Design in an Afrikan Context

The practice of design in an African context needs to be grounded in perspectives of local history and culture (Asabere-Ameyaw et al. 2014). *Afrikan* design necessitates local participatory design processes and practices, taking cognisance of the danger of remaining in a neo-colonial paradigm (i.e. remotely designed cookstoves parachuted in as developmental assistance) (Asabere-Amayaw et al. 2014). Mafundikwa (2009) holds that the complexity of *Afrikan* creative expression and problem solving ability is underestimated due to the deceptively “simple” appearance of designed artefacts. The Western approach of linking cognitive abilities and narratives to traditional forms of literacy, lead to overly simplified narratives, thereby neglecting the complex cognitive practices developed in verbal and multilingual contexts (Bidwell et al. 2011).

Ambole (2016) suggests the necessity of comprehensive transdisciplinary frameworks when designing transformative systems in complex informal urban areas, with multiple actors and networks, spanning multiple modes of knowledge production. Ambole (2016) furthermore proposes co-creative and participatory design methods when attempting to meet the needs of poor communities in sub-Saharan Africa, with an ethnographic-based design approach succeeding where standard design practice has failed.

## METHODOLOGY

To gauge the possible role of an *Afrikan* design approach in improved cookstove projects, Yin

(1999) suggests a qualitative research approach with a literature-based cross-case study method when scanning selected projects, identify matching patterns, analyse general commonalities, uncover insights, and provide explanations.

A systematic bibliographic search on improved cooking stoves that had achieved some measure of success in cookstove dissemination within sub-Saharan Africa was screened down to five projects. This group was scanned for aspects of an Afrikan design approach. The main aspects were summarised, allowing conclusions to be drawn. As no successful large-scale implementation of a design-driven strategy was found in the sub-Saharan region, the three case studies were selected due to the (often unintentional) use of design methods in the programme implementations. The following were selected for review, namely:

- the Jiko Stove Project,
- the Basa Njengo Magogo Project and
- the Tree is Life Trust Cookstove Project.

## **RESULTS**

The literature-based cross-case study of improved cookstove dissemination programmes found that aspects of Afrikan design approaches were present in the selected cookstove projects as summarised below. A focus on the local needs and practices of the beneficiaries is paramount. Near all stove, projects applied participatory techniques embedded in the community with residents and artisans participating in the design process. The inclusion of participatory methods that incorporate the beneficiary as co-designer in a communitarian manner is particularly evident in the case of the Jiko Stove. The use of participatory methods in the Basa Njengo Magogo study was prevalent in the beginning, yet receded towards the end. Behavioural techniques were found in all the projects were used. Common in both the Jiko Stove Project and the Tree is Life Trust Project is the time spent of the development team and the community in coming to a common understanding of the problem, and jointly designing the solution. This success can largely be attributed to the dedication of the designers and the patient support of donors, in contrast to the Basa Njengo Magogo Project, where support was limited.

### **The Jiko Stove**

The Jiko charcoal stove (Jiko meaning quick in Kiswahili), has become a ubiquitous part of Kenyan cookstove culture - its versatility in design lending itself to cooking and roasting meats and vegetables. The success of the ceramic Jiko Stove in Kenya is attributed, in part, placing the user as part of the broader community as the starting point in the dissemination strategies contextualised within the local community and the environmental pressures experienced

(Hyman et al., 1987; Njenga et al., 2014). The Jiko stove success has led to the development of an indigenous relatively self-sufficient national production and dissemination infrastructure for higher efficiency charcoal stoves, with non-governmental organisations acting as technological and developmental intermediaries. This nascent industry developed despite Kenyan duties on the raw material imports used in the construction of the cookstoves (UNCTAD).

The Jiko phenomenon was the brainchild of the late Dr Maxwell Miringu Kinyanjui, a pioneer of a wide range of sustainability initiatives in Kenya, most notably the design and development of the charcoal-saving Kenya Ceramic Jiko, the promotion of commercial reforestation and efficient charcoal production in Kenya (Dunford, 2012). Kinyanjui's design approach approximates a circular design approach. This circular approach is best illustrated by the seed-to-ash philosophy central to Cookswell Stoves – the family-owned stove manufacturing company now run by his son Ted Kinyanjui (Dunford, 2012; Cookswell, 2017). The holistic strategy of the seed-to-ash cycle foresees a virtuous cycle where the planting and sustainable harvest of trees provides the feedstock for energy-saving biomass fuelled stoves, ovens and kilns. Central to the design process was a co-creative process with the final beneficiaries informed a communitarian ethos espoused by Kinyanjui.

The design of the Jiko was in response to the energy needs of Kenyan households, where traditional biomass still accounts for the majority of Kenya's cooking needs. The country's demand for firewood exceeds its supply by an estimated 2 million tonnes per year, leading to deforestation, desertification, droughts and famine. Modern energy services are unaffordable for the majority of the population.

Incremental improvements to the stove design continued after its launch in 1982 in a co-creative manner, increasing the usability, affordability and efficiency of the stove (Dunford, 2012). After prototyping a variety of different designs of efficient cooking stoves, Kinyanjui oversaw the production, marketing and of the cookstove. As part of the design process, Kinyanjui started a small manufacturing business, hiring and training artisans in the manufacture of the stoves, with the goal of creating sustainable communities of practice with skills required to build the cookstoves considered as necessary as the dissemination of the artefact itself. The artisans were assisted in establishing their stove manufacturing businesses. The stove designs were not patented, with the copying of the stove design encouraged, to aid a speedy dissemination process (Dunford, 2012). This cooperation with manufacturers enabled the establishment of viable marketing and distribution networks and ensured consistency in the initial build-quality of the stoves. This cookstove infrastructure provided the base for local women's groups and individuals being trained, thus leaving institutional knowledge and a thriving stove market as a legacy (Chavangi, 1995; Karekezi, 2002). The consistency in the stove's quality and

appropriateness to local cooking needs at an affordable price built confidence among customers and employment opportunities in the stove production sphere.

As part of the dissemination strategy in Kenya, households with relatively higher living standards were targeted initially. This might appear counter-intuitive, yet as producers and local marketers grew their business and achieved economies of scale, the prices started to drop, achieving market penetration among all the other urban segments. By the year 2002, the Jiko charcoal stove initiative had achieved a penetration rate of approximately 50%, while the firewood-based version languished at around 5% penetration. This poor performance has been attributed to the communal lack of incentive to save fuelwood except where it was already scarce. The Jiko design has become the template for numerous stove projects around the world. However, most other attempts have met with failure (Karekezi, 2002; Bazilian et al., 2012). In addition to the initial prototype of the “Kenya Ceramic Jiko” stove, the product range has widened to include ovens and griddles — the charcoal oven reputed to be 70% more cost-efficient than its gas or electricity counterparts (Dunford, 2012).

### Basa Njengo Magogo

One of the most notable programmes to promote clean and safe cookstove behaviour in South Africa was the *Basa Njengo Magogo* alternative fire lighting method for coal-fired self-constructed stoves. While not explicitly a design intervention, the programme used participatory research methods. Developed and piloted by the *NOVA Institute* in 1999, the behaviour change intervention entails inverting the way fires are lit as shown in Figure 18 below.



Figure 18: Basa Jenje Magogo Demonstration (Nova Institute 2017)

The name *Basa Njengo Magogo* originates from Mrs. Nebelungu Mashinini, an elderly grandmother from the eMbalenhle community, who participated in the design process and means “to start a fire like grandmother”. Household air pollution from coal-fired stoves is reduced by applying the suggested top-down ignition method. While laboratory tests confirm a reduction of smoke emissions by 80% a large scale dissemination has not yet been demonstrated (Nuwarinda 2007).

### Tree is Life Trust Cookstove Project

The *Tree is Life Trust* of the Laikipia and Nyandarua Districts in Kenya, is a training and capacity building project assisting local households in the sustainable use of their natural resources. Most of the households depend on firewood and charcoal for cooking and heating, leading to deforestation and a reduction in biodiversity (Kiendi 2016).

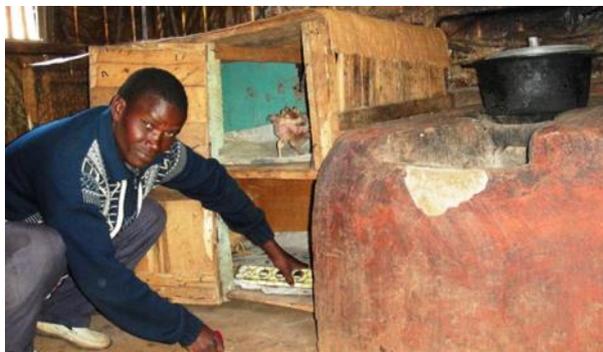


Figure 19: Stove, heater & chicken brooding box, Laikipia District, Kenya (Obiria 2016)

The project provided local entrepreneurial farmers in Laikipia County with the nudge to design and build an efficient ceramic cookstove and space heater, with the added benefit of a chick brooding box as demonstrated in Figure 2. The popularity of the design has been attributed to its simple indigenous design and ease of construction with local materials. The accruing benefits are listed as the fuelwood saved, increased survival rates of hatchlings and a measurable increase in household income notwithstanding a warmer, healthier household in this colder mountainous region (Kiendi 2016; Obiria 2016).

## CONCLUSION

*Afrikan* design approaches, specifically participatory methods informed by a communitarian philosophy, can contribute significantly to shifting the cookstove-related practices of energy-poor sub-Saharan households to a cleaner and safer cookstove culture. The integration of Africa's resilient cultural practices could furthermore provide individual and collective insights for a meaningful redistribution of power to specifically energy-poor women and children. An *Afrikan* Design approach can provide a resilient complex interconnected and at times adversarial dynamic process across disciplines in achieving transformative change.

### Further Research

It is anticipated that a prospective pilot design project in Sibabalwe, an informal settlement on the outskirts of Cape Town in South Africa, could act as a case study in how to apply *Afrikan* design research methods to shift energy-poor sub-Saharan households to a clean and safe cookstove culture. On a broader scale, it is hoped that the study will contribute to fundamentally transforming the underlying socio-cultural dynamics around efforts to achieve the global

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# **Entrepreneurship Education and Eco-preneurship Innovation as Change Agents for Environmental Problems**

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## **ABSTRACT**

Ecopreneurship means carrying out activities that keep the environment clean as well as meeting the business objectives. Given the current environmental problems facing the world, it is flawless that past strategies used to address the challenges have continually failed to prevent environmental degradation. Entrepreneurship is expected to be the next big thing to influence as the country struggles to achieve a balance between a growing GDP, inclusive growth and addressing issues ranging from education, energy efficiency to climate change. This paper attempts to examine the different dimensions of eco-preneurship. It also emphasizes on how to harness the innovative potential of mindful environmental entrepreneurs (eco-preneurs) to encourage more start-up that would produce the environmental technologies needed to address the environmental problems. It also discusses the role of entrepreneurship education in promoting eco-preneurship behavior, presents and outline for possible course that would be integrated into university entrepreneurship education.

**Keywords:** Environmental problems, Entrepreneurship degradation, Entrepreneurship education, Eco-preneurship

## **Introduction.**

The twenty-first century has witnessed numerous environmental problems such as land dilapidation, ever-increasing pollution level, trouncing of biodiversity and climate change which still remain unresolved. These environmental problems, to a large extent, have been traced to human entrepreneurial activity that triggered a continual increase in consumption of environmental resources and an alteration to the natural composition of the environment (Cohen and Winn, 2007; McEwen, 2013). This state of affairs has many explanations but some authors linked it to Schumpeter (1934), who contended that the innovations made by entrepreneurs are the major drivers of economic development and the fundamental factors in trade formation. The neo-Malthusian environmentalists, for example, supported Schumpeter's view but argued that over the past decades economic growth through entrepreneurial activity had not been going hand in hand with the preservation of the eco-system (Kate, Parris and Leiserowitz, 2005; Morelli, 2011). Thus, proponents of the neo-Malthusian ideology suggested that entrepreneurs as agents of "creative destruction" – as Schumpeter lyrically refers to them – could also be agents of a "creative solution" to address global environmental problems by introducing environmentally acceptable ideas, products and services (Dean and McMullen, 2007; York and Venkataraman,

2010). One such environmental approach to economic activity is through “ecopreneurship” and “green product initiatives”. This paper is driven by the truth that long-term sustainability of the economic system does not depend only on measurable growth, but also on ecological aspects of sustainable development goals (York and Venkataraman, 2010). It is an important paper given the need for ecopreneurship to solve contemporary environmental problems through the adoption and application of eco-friendly innovations in Kenya and other countries in the world.

Looking at the current environmental problems facing the world, it is obvious that past strategies used to tackle these challenges have failed to thwart environmental degradation. It is therefore time to give attention to the responsibility that entrepreneurs can take part in solving these nagging environmental problems.(Cohen and Winn, Dean and McMullen, 2007). This paper focuses on how to harness the innovative potential of environmentally conscious entrepreneurs, called ecopreneurs, to encourage more startups that would create the environmental technologies needed to address our environmental problems. It also discussed the role of entrepreneurship education in promoting ecopreneurial behavior and presented an outline for a possible ecopreneurship course that could be integrated into University entrepreneurship education

Environmental degradation is perhaps the most prominent global issue of the 21st century. Academics, policymakers, nongovernmental agencies and governments are all concerned about the increasing levels of land degradation, soil erosion, deforestation, and industrial toxins (Volery, 2002; McEwen 2013) In addition, there are very serious concerns about the negative consequences of ozone depletion, climate change, nuclear radiation, and the destruction of biodiversity (Intergovernmental Panel on Climate Change (IPCC), 2007; United Nations Environment Program (UNEP), 2004, World Resources Institute, 2004). A recent joint report by the World Resources Institute, the World Bank, and the United Nations show the diminishing capacity of five of earth’s most critical ecosystems. 40% of agricultural lands worldwide have been severely degraded through erosion, salinization, nutrient depletion, biological degradation, and pollution. 20% of fish and shellfish has been diminished due to overfishing, destructive, Coastal trawling techniques, and destruction of nursery habitat. Pollution problems have plagued coastal lands because of use of synthetic chemicals and fertilizers. Global warming impacts ecosystem through rising sea levels, warming of the ocean temperatures and changing storm frequency. More than 20% of global forest cover has been removed due to logging and Forest conversion to other land uses. Deforestation has significant impact on biodiversity, e.g., loss of unique plant and animal species. Humans currently use more than 50% of all accessible fresh water; by 2025 demand will reach 70%. Grassland Road building, land conservation, and human induced fires have caused significant loss of grassland and thus loss of biodiversity. (Cohen and Winn, 2007; McEwen. T, 2013 ). “Environmental degradation has not

only brought natural disasters, such as storms, heat waves, droughts, etc., but it has also diminished the vitality and sustainability of the economy. The long term economic and financial impact of environmental degradation, therefore, may be very substantial because a large amount of the world's economic output depends on the sustainability of the natural systems. The long term economic and financial impact of environmental degradation, therefore, may be very substantial because a large amount of the world's economic output depends on the sustainability of the natural systems (Costanza, et al, Kainrath, 2009). According to the International Panel on Climate Change (2007) and the United Nations (2005), economic development is one of the main causes of environmental degradation in the economy. It is not surprising that “business and industry are often viewed as one of the largest contributors to environmental degradation” (Cohen & Winn, 2007, p. 29). Volery (2002) noted that for the past decade economic growth was done without considering the protection of the environment. Traditionally, efforts to address this problem have focused on how and why existing firms can become greener (Cohen & Winn, 2007; York & Venkataraman, 2010). According to York and Venkataraman (2010) these efforts have not led to solving our environmental problems. Entrepreneurs have contributed to solving environmental problems by creating new, more environmentally sustainable products and services ( York & Venkataraman, 2010).

#### Purpose

The purpose of this paper is to contribute to the discussion that proposes entrepreneurship as a solution to the environmental problem. Another principal reason for this paper is that finite resources, such as fish, minerals or gas, are limited in their supply and once consumed, many of them cannot be recreated and we will be left with shrinking or no natural resources if we do not sustain them (Volery 2002). Hence, this paper has revealed how economic activity (entrepreneurship) and consumption of natural resources can operate in a sustainable manner. In addition, this paper supports the argument that there is a need to constantly look for alternatives, e.g. recycling or new sources of energy generated from wind or solar energy in order to integrate environmental concerns into business activity. The focus here is on how to harness the innovative potential of ecopreneurs to take advantage of the entrepreneurial opportunities within environmental degradation and to explain the role of entrepreneurship education in environmental sustainability. According to Cohen and Winn (2007), “ecopreneurs have the potential to resolve our environmental problems and to gradually improve the earth's ecosystem,”

#### Meaning of Ecopreneurship

The term “ecopreneurship: sometimes referred to as “green entrepreneurship” (Schaper, 2002; Taylor & Walley, 2003) “ethical entrepreneurship” (Taylor & Walley, 2003) “enviropreneurship”

(Keogh & Polonsky, 1998) and “environmental entrepreneurship” is a combination of two words ‘ecological (eco) and entrepreneurship which implies the creation of an innovative company that supplies environmentally friendly products and services i.e., “entrepreneurship through environmental lens” (Schaltegger, 2005). Eco-entrepreneurs enter these eco-friendly markets, not only to make profits, but also because they have strong, underlying, green values. They are the combination of strong environmental and social values with an energetic entrepreneurial attitude (Anderson, 1998; Gibbs, 2009). Volery (2002) defined ecopreneurship as environmental responsibility in entrepreneurship, while for Isaak (2005), it is an “existential form of business behavior committed to sustainability”. Ecopreneurs are therefore entrepreneurs who found their businesses based on the principle of sustainability (Kirkwood and Walton, 2010). They are a new breed of eco-conscious change agents who are redefining the way business is conducted and are introducing eco-friendly ideas and innovations in the marketplace. Ecopreneurship is distinguished from social entrepreneurship which focuses on enhancing the social wellbeing of the society (Zahra, Gedajlovic, Neubaum, Shulman, 2009). Ecopreneurship is also different from sustainability entrepreneurship which integrates the three strands of the triple bottom line (economic, social and environmental). Tilley and Young (2009) argues that sustainability entrepreneurship goes further than “environmental” or “social” entrepreneurship as it encompasses a more comprehensive range of the triple bottom line. In other words Ecopreneurship is entrepreneurial activities through the environment lenses.

Spheres of Ecopreneurship

## The Three 'Spheres' of Sustainability



The next section discussed the theoretical rationale, and the evolution and growth of ecopreneurship. It then examined how to harness the innovative potential of ecopreneurs to develop the environmental technologies needed to solve the environmental problems. And, finally, the paper discussed the role of entrepreneurship education in promoting ecopreneurship and suggested an outline for a possible foundation course in ecopreneurship. The paper contributes to the literature by adding to our theoretical understanding of how entrepreneurial action can help solve environmental problems, and by emphasizing the important role of entrepreneurship education in developing the current and potential ecopreneurs. The overarching purpose of the paper is to provide insights for policymakers and educators into ways to foster ecopreneurship.

### Types of Ecopreneurs

#### Environmental Conscious

- They develop innovations that either reduce resource and impact or improve cost efficiencies.

#### Green Entrepreneurs

- They are aware of environmental issues and have their businesses in the environmental marketplace.

#### Innovative Opportunist

- They are financially oriented entrepreneur who spots a green niche or business opportunity

that happens to be green

Ad hoc or accidental entrepreneur

- They spots opportunities that are green, rather than seek out a niche in green spaces

Visionary Entrepreneur

- They built their businesses based on sustainability principles

Self-Employed

- They advocate nature-oriented enterprises e.g. wild life habitat preservation, eco-tourism etc; low desire to change the world and low financial drive

Opportunist

- They involve themselves in environmental technology to help businesses and communities reduce environmental load on water, air and soil. They have a low desire to change the world and high financial drive

Non-profit Business

- They entrepreneurs have high desire to change the world and low financial drive

Successful Idealist

- These are the entrepreneurs who have a high desire to change the world and high financial drive

Green Business

- These are the entrepreneur who do not start green business from scratch, but later discover the advantages of greening their existing businesses

Green-Green Business

- These are the entrepreneurs who designs a business to be green in its products and processes from the scratch

Eco-dedicated

- These are the entrepreneurs who consistently adopt environmentally friendly business practices

Eco-open

- These are the entrepreneurs who partially adopts environmentally friendly business

Theoretical Framework

The report is based on two theories named; Schumpeterian and Ecological Modernization Theories

### 1. **Schumpeterian theory**

This theory provides the theoretical foundation for environmental entrepreneurship. Given that the current solutions to our environmental problems are inadequate for sustainability, there is

need for entrepreneurial action to develop something new, whether it is a production method, technological development, product/service distribution system, or even a new organizational form. (Lennox & York, 2011, p. 9; Tillery & Young, 2009).

## **2. Ecological Modernization Theory**

This theory is a school of thought that can be found in social science. It argues that an economy benefits when there is a move toward environmentalism. It is a unique theory within the scope of “Green Politics” as it is both a policy strategy and an analytical approach to having a discourse on environmental awareness. It is increasingly used in environmental policy analysis ( Spaargaren, 2009, Howes, 2010) because it provides an appropriate framework to explore the roles of actors in society in the process towards achieving best practice environmental outcomes.

According to the Ecological modernization theorists, “the environmental problems facing the world today, act as a driving force for future industrial activity and economic development” as Joseph Huber (Mol, 1995) the father of this theory sees it, entrepreneurs are the central agents of change in that process of transformation to avoid an ecological crisis (Gibbs, 2009; Tillery & Young, 2009). Entrepreneurial action consequently is the best solution to our environmental problems because this new generation of ecopreneurs is seeking to combine environmental awareness and conventional entrepreneurial activity to achieve entrepreneurial success. Ecopreneurs have the potential to be a major force in the overall transition towards a more sustainable business paradigm. Ecopreneurship is also important because eco-innovations will be the future competitive advantage of companies and countries (Klimova & Zlek, 2011). They argued that if companies and countries want to be successful in the international market, they cannot rely on having low cost as their competitive advantage; but rather on new and innovative environmental technologies, services and processes which will be the more significant sources of competitive advantage. There are some practical business reasons that give good reason for the need for ecopreneurship to solve our environmental problems. First, our restricted resources, for example fish, minerals or gas are limited in their supply. Once consumed, many of them cannot be recreated and we will be left with diminishing or no natural resources if we do not sustain them. Also due to economic activity and consumption, most of our resources become waste which results to major problem of pollution. These problems seriously affect humans and the ecosystem and could lead to greenhouse gas accumulation and potential climate change (Volery, 2002,). To maintain them, first ecopreneurship is constantly looking for alternatives, e.g. recycling or new sources of energy, such as wind, water, and solar. Second, the global population growth is also influencing ecopreneurship. Ecopreneurs are therefore busy finding

new technologies to protect the environment, and to ensure that there are enough resources to fill the needs of both the current population and future generations. Third, biodiversity loss justifies entrepreneurial action to solve environmental problems.

The twenty-first century has witnessed numerous environmental problems such as land dilapidation, ever-increasing pollution level, trouncing of biodiversity and climate change which still remain unresolved. These environmental problems, to a large extent, have been traced to human entrepreneurial activity that triggered a continual increase in consumption of environmental resources and an alteration to the natural composition of the environment (Cohen and Winn, 2007; McEwen, 2013). This state of affairs has many explanations but some authors linked it to Schumpeter (1934), who contended that the innovations made by entrepreneurs are the major drivers of economic development and the fundamental factors in trade formation. The neo-Malthusian environmentalists, for example, supported Schumpeter's view but argued that over the past decades economic growth through entrepreneurial activity had not been going hand in hand with the preservation of the eco-system (Kate, Parris and Leiserowitz, 2005; Morelli, 2011). Thus, proponents of the neo-Malthusian ideology suggested that entrepreneurs as agents of "creative destruction" – as Schumpeter lyrically refers to them – could also be agents of a "creative solution" to address global environmental problems by introducing environmentally acceptable ideas, products and services (Dean and McMullen, 2007; York and Venkataraman, 2010). One such environmental approach to economic activity is through "ecopreneurship" and "green product initiatives".

Innovations can change economy and society fundamentally. In creating an innovation, one should be able to overcome limitations. Sustainable development needs continuous innovations and the entrepreneur who can achieve the environment purposes with superior innovations will be successful in the market. Entrepreneurship is viewed as a process of finding market opportunities and organization resources which are needed to use the opportunity to gain long term results. The player who has creative and innovative abilities for environment advancement in their core business are called 'ecopreneurs'. Ecopreneurship is an entrepreneurship concept which is not profit oriented only but also concern to other aspects, especially the environment aspect. Ecopreneurship is an entrepreneurship behavior which focusing on the environment sustainability in the future. According to Schaltegger, S.[2002], ecopreneurship is a combination of two words, ecology (eco) and entrepreneurship. Ecopreneurship is marked with several fundamental aspects from entrepreneurial activities which oriented to management system or technical procedures and more focused on the initiatives and personal or team skills to achieve market success with environmental innovations.

## **Literature Review**

A basic review of literature is made in this paper. According to Lawal (2016), a basic review of literature depicts planned efforts to locate, appraise and synthesize leading available evidence relating to a specific research problem in order to provide informative and evidence based answers. For the sake of a more comprehensive structure of this paper, discussions are presented under the following sub headings

### **Empirical review**

#### **Entrepreneurship and Innovation**

Most studies on entrepreneurship underscore its strong relationship with Innovation. Innovation is seen as the core action and a specific instrument of entrepreneurship (Drucker, 1985). Entrepreneurship and innovation can be considered as virtually synonymous (Acs & Audretsch, 2005). Many industries characterized by high rate of innovation also have high rates of new venture creation (Cooper, 2005). Entrepreneurship gives birth to new commodities, techniques and goods, booting human progress forward and rendering the old obsolete, leading to the extinction of whole branches of industry and creation of new ones (Mellor, 2009). Entrepreneurship makes it possible to make new business where no previous industry or business existed. Entrepreneurs also make it possible to recombine existing business processes to form new value chains (Porter, 1990). The task of an entrepreneur, according to Schumpeter, is to indulge in creative destruction. The entrepreneur searches for change, responds to it and exploits it as an opportunity. Innovation is a specific instrument of entrepreneurship, and an entrepreneur indulges in systematic knowledgebased innovation, which can be viewed as a purposeful and organized search for changes and systematic analysis of opportunities offered by such changes (Drucker, 1985). According to Kirzner (quoted in Kopplan & Minniti, 2005), entrepreneurs innovate and entrepreneurship encompasses alertness to new opportunities and seizing such opportunities by taking innovative action. Entrepreneurs, including start-up companies and venture capitalists are key stakeholders in the innovation processes (Zilbermann, 2005). Thus, innovation is the core action of an entrepreneur and his/her source of value addition to the society. There has been a debate in the literature of entrepreneurship on the relative effectiveness of established firms versus entrepreneurs on creating innovations. A classical view, attributed to eminent past economists such as Joseph Schumpeter (1942), has been that entrepreneurs have a competitive disadvantage for undertaking innovations since they being too small would fade away as the victim of their own inefficiencies. However, recent empirical evidence suggests that new ventures and small entrepreneurial firms play a key role in generating innovations, at least in certain industry and 6 11th International Entrepreneurship Forum Kuala Lumpur, Malaysia, 3-6 September, 2012 spatial contexts. Entrepreneurship plays a crucial role in innovation by providing a mechanism for knowledge to spill over from the

organization producing that knowledge, to the (new) organization commercializing it (Acs and Audretsch, 2005). Entrepreneurs are in a much stronger position to reply to external threats, changes in the market and similar challenges. They may be in a stronger position to innovate (Mellor, 2009)

Entrepreneurship education benefits students from all socioeconomic backgrounds because it teaches students to think outside the box and nurtures unconventional talents and skills. Furthermore, it creates opportunity, ensures social justice, imparts confidence and stimulates the economy. Entrepreneurship promote economic opportunity and it can serve as an agent of social justice. Ecopreneurship is an entrepreneurship concept which is not profit oriented only but also concern to other aspects, especially the environment aspect. Ecopreneurship is an entrepreneurship behaviour which focusing on the environment sustainability in the future. This is an opportunity for ecopreneurs to produce products, services, techniques and organizations model which substantially reduce the environmental impact and increase the quality of life. One of ecopreneur focuses is to use the waste from productions into something useful and economical value.

### **Eco - Innovation**

Rennings (2000) suggests that the distinctive feature of eco-innovation as compared to innovation in general is a concern about the direction and content of progress. In particular a concern about whether innovation leads to the mitigation or resolution of an environmental problem? The “Innovation Impacts of Environmental Policy Instruments” - project introduced the term environmental innovation and defined it very broadly: “Eco-innovations are all measures of relevant actors (firms, politicians, unions, associations, churches, private households) which; develop new ideas, behaviour, products and processes, apply or introduce them, and which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets.” Factor reduction refers to the idea of reducing the resource use per unit of service or product by a certain factor, and can be achieved through a combination of technological, financial and lifestyle changes. It is important to point out here, that the idea behind factor X reduction is that the actual environmental effect of an innovation rather than the intention behind the innovation determines if an innovation is environmental. Rennings (2000) highlights the danger of a technology bias in the understanding of what constitutes an eco-innovation. He argues that unsustainable development itself is a result from technology outpacing changes in social organization, and thus emphasizes the importance of social innovations such as lifestyle-changes in order to tackle ecological problems. In this regard,

authors (Wagner, 2008), Distinguish between integrated and end-of-pipe technology for environmental impact reduction. End-of-pipe or additive technology refers to measures mitigating the environmental effects of an essentially polluting or otherwise environmentally harmful product or service e.g. waste treatment, recycling or waste disposal. This is contrasted by the integrated systems approach which aims at every step of the way to minimize the environmental effect of the system, so that only little or no need for waste treatment or other mitigation arises. An example in case is a gasoline-powered car with a catalytic converter in the exhaust as compared to an electric car. The catalytic converter removes only the most harmful by-products of the fumes created by the essentially harmful internal combustion engine, while the electric car delivers the same service (individual transportation) without the exhaust fumes. In order to analyse and compare eco-innovation in different companies, one needs a scale, a unit of measurement, at least in a metaphorical sense. Many attempts have been made to classify or categorize innovations, mostly according to significance of the innovation, and/or the methods and procedures used in their development.

### **Integrating Ecopreneurship into Entrepreneurship Education**

Entrepreneurship students are an important target group for the development of innovation and entrepreneurial activities in the field of sustainability. However, the entrepreneurial capability of the students and the number of courses focusing on ecopreneurship and sustainability are still limited (Fletcher, Knol, & Jamicki (2012). In response to the requirement for more courses in ecopreneurship and sustainability entrepreneurship, this section describes integrating ecopreneurship into the entrepreneurship curriculum.

According to Bridges and Wilhelm (2008), one of the challenging curriculum issues is whether to have a course entirely dedicated to ecopreneurship or to integrate ecopreneurship into current course being offered. They argue that if the second option is chosen, there is still the question of whether to infuse sustainability into the various topics within a traditional course or to include it as a separate, stand-a-alone module within a course. The particular pedagogical approach selected, they suggested, will depend on the resources of the department and the university, faculty interest and expertise, and student interest in the topic, among other factors. Regardless of the approach that is selected, “the curriculum must cause students to challenge the following common assumptions: Humans are the dominant species and separate from the rest of nature, Resources are free and inexhaustible. Earth’s ecosystems can assimilate all human impacts. Technology will solve most of society’s problems, All human needs and wants can be met through material means,. Individual success is independent of the health and wellbeing of community’s cultures, and the life support system” (Cortese, 2003).

According to Richardson, Irwin and Sherwin (2005), the knowledge base and skills sets needed to become an ecopreneur are very broad. The list includes awareness of both local and global issues, awareness of future trends, acquisition environmental values, and engagement in ecological or systems thinking.

Sustainability also identified additional skills sets needed by the entrepreneurship student: the ability to seek new ways to address needs, the ability to identify new business models that support the resulting innovative products and services, ability to develop buy-in and to gain support of a senior champion. In addition, ecopreneurship knowledge and skills must help graduates understand the critical challenge of ecopreneurs, i.e. producing goods that can be distributed, consumed, and disposed of in a manner that does not affect the environmental quality of the lives of future generations. Above all, ecopreneurship programs need to graduate students who understand environmental entrepreneurship and who can apply sustainability frameworks to design new products, services, and processes.

Students were assigned readings, cases, as well as present current event articles from the business press related to the ecopreneurship topic under discussion. Working in groups, students were to propose entrepreneurial solutions to pressing environmental problems. Some examples of topics would include products or services that were contribute towards reducing energy consumption, conserving energy and water, improving water purification and filtration, improving waste management systems, and exploring alternative energy sources. Also, students were asked to present a sustainability plan/report for a given company or government entity.

The pedagogy for the course was to emphasize active, experiential, inquiry-based learning and real world problem solving in the classroom, on the campus and in the local community. We all know from the conventional wisdom and from educational research, that students retain 80% of what they do and only 10 to 20% of what they hear or read. Therefore, to ensure long term retention of the knowledge, skills and values, the curriculum will provide learning experiences for students to work on actual, real-world problems facing their campus, community, government, and industry.

### **Summary and Conclusions**

The focus of this paper was to find out how entrepreneurship education and eco-preneurship innovation can be the change agents for environmental problems by taking the advantage of the entrepreneurial opportunities within the environmental degradation and to explain the role of education in environmental sustainability. Based on our review of the literature, most researchers agree that environmental problems do represent entrepreneurial opportunities. Despite the changes in legislation and regulations to protect the environment, the United States

and various other countries are still facing many environmental problems, e.g., climate change, population growth, overflowing landfills, water scarcity, fuel shortages, and water and air pollution (Oskamp 2000). If we are to solve these problems, entrepreneurship is a major part of the answer. According to Shepherd and Pratzelt (2011) “entrepreneurial action can preserve the ecosystem, counteract climate change, reduce environmental degradation and deforestation, improve agricultural practices and freshwater supply, and maintain biodiversity.

Secondly, ecopreneurs are not all the same. Some are environmentally oriented and start green businesses, some are partially environmentally oriented, and others only deal with environmental issues when they are forced to by external factors (Schick, et al 2002) The difference, they suggested, is the attitude of the entrepreneurs. One possible reason, they contended, is that for most of these ecopreneurs, environmental awareness was developed since childhood and has continued to be an integral part of their businesses. Ecopreneurship has fostered the community’s awareness to the environment because it has succeeded to disenchant community that environment needs to be preserved by reducing rubbish and separating organic and inorganic rubbish, thus the recycled product process is easier and flexible. Simulations and trainings which are given to community about ways to improve their environment not to be polluted are simple, so anyone is capable to do so. Entrepreneurial education eventually has had an important role to keep the environment preservation. Ecopreneurship has also increased the economy to build independent community in gaining mutual benefits. Individual creativity needs to be raised and supported by good cooperation between one another to increase the profit. If this effort is continuously developed, it would result in mutual community economy growth, not just the individual benefits that would be developed. Thus, collaboration between, environment, social, and economy are key factors in eco-preneurship implementation. This research conceptual model can be used by entrepreneurs, academics, government, and others who have benefited from the eco-preneurship concept implementation. Further research can be conducted with empirical test of proposed model, and to test the appropriateness of this model.

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# **A Review of Drivers of Technology Adoption in the Hospitality Industry in Kenya.**

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## **ABSTRACT**

In July 2016, Kenya held a 14<sup>th</sup> Session of the United Nations Conference for Trade and Development (UNCTAD) to discuss the potential of emerging nations in unlocking their growth on the back of technology. UNCTAD estimates that, the global value of ICT platforms has increased by 38 per cent from 2013 to 2016. It is apparent that adoption of technology in SMEs offers enormous opportunities for growth and development of global economies especially in emerging nations. In Kenyan hotel industry, the small and medium hotel enterprises are often flooded with many similar, often easily substitutable service offerings and of sub-standard quality, which eventually can affect the performance of the industry. Adoption of information technology presents a platform for hotels to achieve efficiency of operations and innovation of unique products and service. However, little seems to be known on the drivers that can influence such adoption. This study explored drivers of technology adoption in hospitality industry in Kenya. The study adopted a qualitative approach by reviewing and analyzing existent literature on the topic under study. Based on the review of selected literature, the findings of this study contend that in order to achieve operational efficiency, most hotels adopt basic technologies. This study proposed an integrated framework of drivers of technology adoption in hospitality industry. However, this paper, recommends a quantitative study to investigate the validity and reliability of the proposed conceptual framework in order to gain insights into how technology can truly influence the performance of hospitality enterprises in the Kenyan market context.

**Key words:** Hospitality, Information Communication Technology, Hotel Performance

## **1.0 BACKGROUND INFORMATION**

Hospitality and tourism enterprises are expected to deliver their services and products in the most effective and efficient manner possible, therefore, adoption and use of information and communication technology (ICT) plays a critical role in overcoming this challenge (Duffy 2010). The use of technology in hospitality SMEs offers enormous opportunities for growth and development of global economies especially in emerging nations like Kenya. In the recent past, Kenya held a Fourteenth Session of the United Nations Conference for Trade and Development (UNCTAD) to discuss how emerging nations have the potential to unlock their growth on the back of technology- specifically e-commerce. UNCTAD estimates that, the global value of

ecommerce platforms has increased by 38 per cent from 2013 to 2016 (Ngahu, Mputhia, Wachira, Gaya, Wairimu, Yieke, & Kiunga 2016).

Globally, the hotel industry begun to embrace technology into its operations and management processes since the Seventies of the 20<sup>th</sup> Century. The use of Property Management Systems (PMS) and the Central Reservation System (CRS) emerged as early as the Seventies of the 20<sup>th</sup> Century. Since then, many systems that are sophisticated have been developed to improve interoperability and interconnectivity, as well as provision of automatic management of reservations. The use of Global Distribution Systems (GDS) begun in the late 1980s. The internet revolution, known as network of networks started in 1990s, but it is since 2000 when intense transformation in the ICT's took place that ushered in other related technologies, like Wireless-radio connection and Wi-Fi. At same time, the blogs as a platform through which users collaborate in the construction of knowledge came into existence. Tourism and travel webs, which link the concepts of virtual communities or social networks were later on developed (Pedroche, Antón, Andrada & Karaboytcheva 2015).

Pedroche *et al.*, (2015) notes that hospitality operations have encountered a proliferation of different mobile technologies such as Personal Digital Assistants (PDA), 3G and Global Position Systems (GPS) among others. From an international viewpoint, hotels are increasingly adopting the use of technology information technology to improve productivity of employees and satisfaction of customers (Ham, Kim & Jeong 2005; Lam, Cho & Qu 2007). According to Oltean, Gabor and Contiu (2014) the most common information technologies in adopted in hotel operations include front-office information system such as Fidelio and Global distribution systems (GDS) such as Worldspan and Amadeus. Fidelio, Worldspan and Amadeus are used to make reservations. Besides hotel management information systems such as Medallion Property Management System (Medalion PMS) have been adopted to manage hotel operations, regardless the structure and number of rooms. Other systems commonly used include Expressoft Interface Manager, eXpresSoft Wireless Check, eXpresSoft Master and Customer Relationship Management (CRM) applications (Oltean *et al.*, 2014).

On the other hand, Mwai (2016) study on adoption of technology in the Kenyan hospitality sector opines that the sector economy continues to face a myriad of challenges which stifle the adoption. Among such challenges, include poor infrastructure, inaccessibility to credit facilities, technological change in which many small business enterprises appear to be unfamiliar with. Consequently, foreign firms and international firms remain in the forefront in accessing the new technologies as opposed to the local enterprises. As a result, local hospitality enterprises are subjected to intense competition from well established international chain and franchise hotels, even though customers continue to pile pressure in demanding customized quality products and

services (Mwai 2016).

Besides, Mwara (2012) underscores that the Kenyan hospitality markets face rivalry and competition occasioned by many changes in the Kenyan economy because of liberalization, globalization, technological advancement and more enlightened customers. Furthermore, the industry is often flooded with many similar, often easily substitutable service offerings, often of sub-standard quality products. Hence, adoption of information technology presents a platform for hotels to achieve efficiency of operations and innovation of unique products and service.

Despite immense benefits accrued to technology, the Kenyan hospitality sector seem be slowly embracing radical technologies. As observed by Mwai (2016), one of the challenges which impedes technology adoption in Kenyan hospitality industry is lack of adequate information on technology change and adoption. Besides, few studies seem to have assessed the drivers of technology adoption especially in the Kenyan context. This study is motivated by the need for information on drivers that can influence adoption of technology that can surmount the outlined challenges and positively influence performance.

## **1.1 Research Questions**

This study seeks to investigate the following specific objectives:

1. To investigate the drivers of technology adoption in the Kenyan hospitality industry?
2. To propose a holistic framework of drivers of technology adoption in the hotel industry.

## **2.0 Literature Review**

Globally, studies have found that the hospitality industry has been keen to adopt information technology. Moreover, literature suggests that technology is regarded as a main source of sustainable competitive advantage and a strategic weapon, especially in the tourism and hospitality industries (Duffy 2010). Though, according to Sigala (2003) the level of technology adoption varies amongst tourism enterprises.

Globally, several studies have propounded frameworks for drivers of technology adoption in the hotel industry. For instance, Duffy (2010) study suggested a framework with the main drivers being technology acceptance, (Technology Acceptance Model), organizational readiness, internal environment and barriers to adoption. However, the study focused greatly on micro and small tourism enterprises in Ireland. Besides, Morteza, Hong, Sabouri, and Zulkifli (2012) proposed a model with a classification of internal and external drivers. Morteza et al., (2012) posit that internal factors include top management, a firm's resources, end users and

organizational characteristics. External factors comprise characteristics of IT products, external and competitive pressure, external IT consultants and vendors, and government.

An assessment of Morteza *et al.*, (2012) framework reveals a weakness in the framework to appreciate the hospitality environmental context with respect to the role of employees and customers in the adoption process. According to Abdelbeary (2011), the willingness to adopt any new technology depends on the benefit the technology will have on employees. On the other hand, Hemmington (2007) states that hospitality customers do not buy customer delivery, but experiences. Therefore the role of technology in packaging the product is key. However, the fact that the customer is largely involved in the co-production of the service, it is also important for the customers to be involved in the adoption process. Besides, the high level of fragmentation of sectors of hospitality calls for a more integrated framework that is applicable to the fragmented hospitality sectors. Furthermore the model fails to appreciate other variables that may mediate the adoption process.

On the other hand, Oliveira and Martins (2011) reviewed a Technological, Organizational and Environmental (TOE) framework initially developed by Tornatzky and Fleischer in 1990. According to Tornatzky and Fleischer (1990), technological context, organizational context, and environmental context for IT adoption are the main drivers of technology adoption. Technological context describes both the internal and external technologies relevant to the firm which include practices and equipment, as well as the set of available technologies external to the firm. Organizational context refers to descriptive measures about the organization such as scope, size, and managerial structure. Lastly, environmental context is the arena in which a firm conducts its business—its industry, competitors, and dealings with the government.

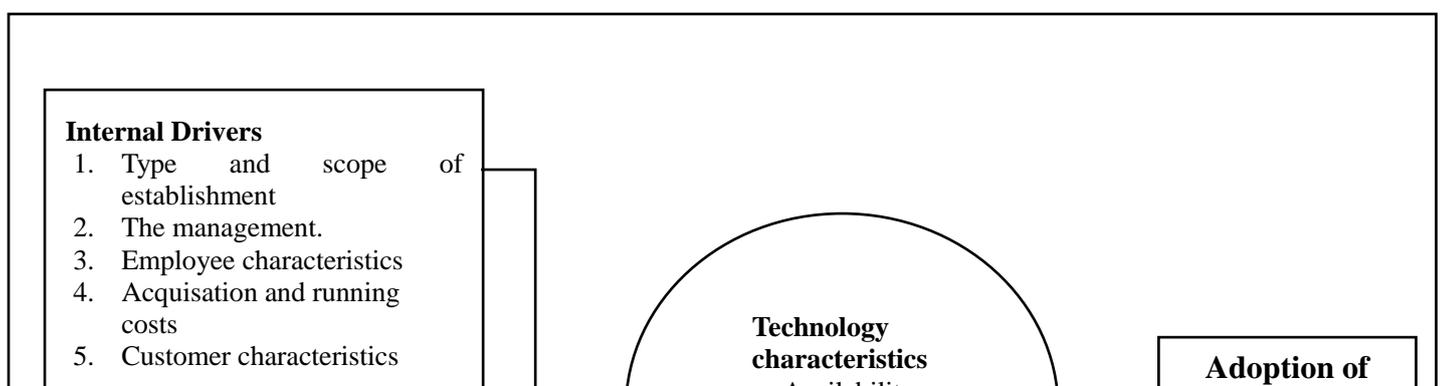
However, the TOE framework takes a general approach to adoption of technology. There is no empirical evidence of the application of the framework in hospitality industry (Oliveira & Martins 2011). Besides, the study was done in Europe, a study area which has different environmental factors compared to Kenya, hence the need to review the framework in light of the Kenyan hospitality industry context.

In the Kenyan context, Mwai (2016) puts forward a framework which can be used to guide hospitality enterprises to adopt technology. The framework includes the following variables; (1) market characteristics, (2) customer characteristics, (3) initial ICT installation and running costs and lastly (4) ICT and its characteristics. According to the market characteristics, the study explains that hotels may differ in their levels of ICT adoption propensity based on the profile of visitors, the size of the market, or the intensity of competition. Concerning customer

characteristics, the study observes that hotels may adopt ICT due to demands of customers, who look forward to flexible, specialized, accessible and interactive products and communication with principals. Thirdly concerning costs, the study posits that investment costs are generally much higher in less developing countries such as Kenya. Due to such high costs, hotels in Kenya may struggle to adopt technology.

While the framework suggested by Mwai (2016) study seems to project a more realistic illustration, one weakness with the framework rests on the fact that the framework narrowly focuses on internal drivers of technology adoption and fails to appreciate other external drivers propounded by Morteza *et al.*, (2012) such as availability of the technologies and the government policies and regulations on their adoption and use. Besides, the framework fails to appreciate the unique nature of the hospitality industry in terms of the characteristics of its products.

Based on the review of existent literature on drivers of technology adoption, this study proposes a hybrid framework for adoption of technology in the hospitality industry. The proposed framework originates from a review of the following previous studies; Duffy (2010); Oliveira and Martins (2011); Morteza *et al.*, (2012) and Mwai (2016). The framework attempts to address the inadequacies raised from the studies reviewed. Besides, the framework is justified on the grounds of the unique characteristics of the hospitality industry, specifically on the role of employees and customers, the intangibility, variability, perishability and the lack of ownership of the hospitality products. The framework appreciates the mediation role of the cost and availability of the technology in the adoption process. The framework is shown in figure 1.0:



**Fig. 1.0:** Integrated framework of drivers of technology adoption in the hospitality industry.

**Source:** Duffy (2010); Oliveira and Martins (2011); Morteza *et al.*, (2012) and Mwai (2016)

### 3.0 Methodology

The study adopted content analysis research design. The study took a qualitative approach by reviewing previous studies conducted on drivers of technology adoption in the hospitality industry to saturation. The table 3.0 below illustrates the summary of the reviewed studies.

**Table 3.0:Summary of Reviewed Studies**

Sn. No	Authors	Analyzed Variables	Methodology Adopted
1.	Duffy (2010)	<ul style="list-style-type: none"> <li>i. Technology Acceptance Model (TAM)-Perceived usefulness, Ease of use</li> <li>ii. Organizational readiness and External pressure-</li> <li>iii. Internal environment- expertise, support from management or owners, user perceptions, efficiency and effectiveness of technology</li> </ul>	<ul style="list-style-type: none"> <li>a) Design- exploratory and explanatory</li> <li>b) Methodology-Three-phase research process. <ul style="list-style-type: none"> <li>i. Phase 1A-Respondent completion postal questionnaire</li> <li>Phase 1B-Hotel web presence survey</li> <li>ii. Phase 2A-Focus groups and</li> </ul> </li> </ul>

		iv. Barriers- location of the firm, security concerns, costs, capital, personal background, industry issues e.g. seasonality.	<p>respondent completion of questionnaires</p> <p>Phase2B-In-depth interviews</p> <p>iii. Phase3-Respondent completion of questionnaires</p> <p>c) Study area- Ireland</p>
2.	Morteza, Hong, Sabouri, and Zulkifli (2012)	<p>i. Internal factors-</p> <ul style="list-style-type: none"> <li>-Owner/manager characteristics</li> <li>-Organizational behaviour and characteristics</li> <li>-Firm's resources</li> <li>-IT users</li> </ul> <p>ii. External factors</p> <ul style="list-style-type: none"> <li>-Government</li> <li>-IT vendors and consultants</li> <li>-IT products in the market</li> <li>-external and competitive pressure</li> </ul>	<p>a) Content analysis of theories, empirical research and case studies related to IT adoption)</p> <p>b) Study area-Malaysia</p>
3.	Oliveira and Martins (2011)	<p>i. Technological context- internal and external technologies relevant to the firm</p> <p>ii. Organizational - scope, size, and managerial structure.</p> <p>iii. Environmental context - industry, competitors, and dealings with the government.</p>	<p>Content analysis of the following types of empirical studies:</p> <p>a) Studies that used only the TOE framework and</p> <p>b) Studies that used the TOE framework combined with other theories</p> <p>c) Study area-Portugal</p>
4.	Mwai (2016)	<p>i. Market characteristics- profile of a hotel's visitors, the size of the market, and intensity of competition,</p> <p>ii. Customer characteristics-customer demand for flexible, specialized, accessible and interactive products and communication methods</p> <p>iii. Initial ICT installation and running costs</p>	<p>a) Design -Descriptive research</p> <p>b) Target population- hospitality managers and technicians</p> <p>c) Sample size -100</p> <p>d) Instrument- questionnaires</p> <p>e) Study area-Kenya</p>

	iv. ICT characteristics	
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**Source:** Duffy (2010); Oliveira and Martins (2011); Morteza *et al.*, (2012) and Mwai (2016).

#### 4.0 Findings

From the findings, it emerges that adoption of technology in hospitality organizations is influenced by near same drivers which range from internal to external issues. By use of the Political, Economic, Social and Technological (PEST) Model in the analysis of the drivers, it emerges that the most cross cutting drivers in all the studies (Duffy 2010; Morteza *et al.*, 2012; Oliveira and Martins 2011 and Mwai 2016) relate to the socio-economic issues. However, few studies (Morteza *et al.*, 2012 and Oliveira and Martins 2011) acknowledge the role of government in the adoption process. Besides, no study appreciates any mediation role in the adoption process. The summary of the findings is shown in table 3.1 below:

**Table 3.1: Summary of Findings**

<b>Authors</b>	<b>Political</b>	<b>Economic</b>	<b>Social</b>	<b>Technological</b>
Duffy (2010)	None	<ul style="list-style-type: none"> <li>▪ Costs and capital</li> <li>▪ Industry issues e.g. seasonality.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Organizational readiness</li> <li>▪ External pressure</li> <li>▪ Expertise and perceptions of users</li> <li>▪ Management or owners support</li> <li>▪ Location of the firm,</li> <li>▪ Security concerns</li> <li>▪ Personal background</li> </ul>	<ul style="list-style-type: none"> <li>▪ Technology Acceptance Model (TAM)- Perceived usefulness and ease of use</li> <li>▪ Efficiency and effectiveness of technology</li> </ul>

Morteza, Hong, Sabouri, and Zulkifli (2012)	The Government	<ul style="list-style-type: none"> <li>▪ IT products in the market</li> <li>▪ Competition</li> </ul>	<ul style="list-style-type: none"> <li>▪ IT users</li> <li>▪ Owner/manager characteristics</li> <li>▪ Organizational behaviour and characteristics</li> <li>▪ Firm's resources</li> </ul>	<ul style="list-style-type: none"> <li>▪ IT vendors and consultants</li> </ul>
Oliveira and Martins (2011)	<ul style="list-style-type: none"> <li>▪ The government</li> </ul>	<ul style="list-style-type: none"> <li>▪ Competition</li> </ul>	<ul style="list-style-type: none"> <li>▪ Organizational scope, size, and managerial structure.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Relevant technologies to the firm</li> </ul>
Mwai (2016)	None	<ul style="list-style-type: none"> <li>▪ Market characteristics</li> <li>▪ ICT costs</li> </ul>	<ul style="list-style-type: none"> <li>▪ Customer characteristics</li> </ul>	<ul style="list-style-type: none"> <li>▪ ICT characteristics</li> </ul>

**Source:** Analysis of findings (2018).

## 5.0 Discussions

Based on the content analysis of the previous studies it apparent that the most common drivers of technology adoption in the hospitality industry relate to internal and external environment of the industry. The drivers which relate to internal environment can be referred to as internal drivers and those that relate to external environment of a business can be referred to as external drivers. The internal drivers relate to organizational factors such as end user characteristics, resources available and the management support. On the other hand, external drivers relate to regulatory frameworks, policies, competition and market characteristics (Duffy 2010; Oliveira & Martins 2011; Morteza *et al.*, 2012 & Mwai 2016).

However, all the drivers from the previous studies reviewed are generic, this study proposes the following more specific internal drivers: (1) type and scope of service, (2) the management, (3) employee characteristics (4) customer characteristics and finally, (5) the acquisition and running costs. As The type and scope of the establishment will determine the type and level of technology adoption (Sigala 2003). The management can also determine the decision whether to adopt technology or not based on the strategic direction of the establishment. Besides, the success or failure of the adoption process heavily rests on the management (Morteza *et al.*, 2012). It is important to incorporate employees' needs and concerns in the adoption process too (Abdelbeary 2011). Moreover, the fact that the customer is largely involved in the co-

production of the service, it is also important for the customers to be involved in the adoption process.

Conversely, the privacy concerns of guests should be considered in the adoption process, otherwise the technology may expose the guests to cybercrime and privacy breaches. Recently, Kenyan recreation centers have been a target to terrorism acts from radical groups like the Alshaabab, this has escalated the need to perform security checks at entrances of malls, restaurants and place of leisure. Patrons frequenting leisure centers have been often required to allow these checks to be done to their bags. Despite understanding of the reasons behind this requirements, there has been resistance from some patrons, especially high-end patrons who may feel that their privacy is invaded. Hotels can be lost in the conflict of interests-to subject these clients to security checks and lose on their market or to accommodate their 'privacy' concerns. Concerning employees, if the technology is highly customer centered and fails to incorporate the needs of employees, employees are likely to resist its adoption (Abdelbeary 2011).

Lastly, in line with Duffy (2010) and Mwai (2016) costs of acquisition and operation may stifle the adoption process. Operation costs may include maintenance costs may include the costs of training employees on the use of technology. Since the hospitality industry experiences a high employee turnover rate, such turnovers may be costly to cope with since training will be required often.

The industry specific external drivers include: (1) market structure and characteristics, (2) the government regulations and (3)intensity of competition. Just like the Kenyan hospitality market, globally most hospitality firms operate in perfect competition structures, with a large number of small firms offering identical products (Shetty 2008). Since such markets face intense competition, they may have high affinity to adopt cutting-edge technology in order to survive. Furthermore, the hospitality industry is characterized by unique fetures which includeintangibility, variability, perishability and the lack of ownership of the hospitality products. All these features may drive the adoption process in order to manage challenges which stem from the unique features.

Concerning governemnet regualtions and intensity of competiton, the industry may be compelled to adopt technology in order to overcome the challenges these drivers may exert on the industry. For instance, the Hotel And Restaurant Act 2009 requires hoteliers to keep a register of the resident guest. Therefore, such a requirement may compel hotels to adopt a technology to management the reservations. It is important to note that availability of

technology, its efficiency and usability can either heighten or lessen the adoption process. Therefore, such factors can moderate the adoption process. For instance, in the event where technology is easily available, highly efficient and easy to use, its adoption may be enhanced as opposed to when the technology is difficult to access, inefficient and complex to use.

### **5.1 Conclusion, Implication and Limitation of the Study**

Technology adoption in hospitality industry is mostly influenced by socio-economic drivers and least influenced by governmental requirements. Besides, the objectives of technology adoption seem to focus more on the commercial and economical benefits towards the industry than the improvement of customer experiences and relationships.

However, this study has certain limitations. First, just like the previous studies reviewed so far, falls short of scientific methodologies that can support scientific analogies of data analysis. Evidently, most of the studies reviewed, adopted descriptive and exploratory designs. Future hospitality research should depart from such methodologies and embrace quantitative methodologies such as correlational and to show causality.

Secondly, due to the limitations of qualitative research in generalisation of the findings and the extensive fragmentation of the hospitality industry, the proposed framework may not be applicable for all firms. Therefore, the findings of this study require empirical testing to determine its relevance and conformity in the practical setting.

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# **Sub-Theme: Science, Technology, Engineering, Mathematics and Innovation for Industrial Transformation**

## **Path Loss Propagation Model Prediction for GSM Mobile Networks in Nigeria**

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### **ABSTRACT**

This research is aimed at predicting propagation path loss model which can be helpful in planning the best Global System for Mobile Communication (GSM) networks in Dutse town, Jigawa state Nigeria. The methodology employed is measurement and instrumentation method. Digital wheel meter and handheld Spectrum analyzer (AARONIA AG HF 2025E spectran) were used to measure signal path loss at Garu, Fagoji, and Takur and Gida dubu sites in Dutse town respectively. The outdoor fields' measurements were carried for the GSM services provided by Airtel, MTN, Glo and Etisalat communication companies in the state. The average measured path losses were compared with the predicted and result were presented in tabular and graphical forms. The result presented that the variance of the average values lies between 2 to 7dB which is within the acceptable range. This shows a significant correlation between the measured and predicted models. Therefore the empirical model developed from Log-Normal shadowing concept can work for GSM network service providers for planning and optimization their services in Dutse, Nigeria.

**Index terms:** GSM Network Service Providers, Path loss Measurement, Propagation Model, Planning and Implementation.

## **I. Introduction**

Access to Global system for mobile Communication (GSM) has dramatically increased in Africa since late 2000s. In Nigeria it became most active industry in 2004 to the present day. The quality of service provided by the key players in the industry becomes so worrisome by the users. The numbers of network service providers continue to increase, but the quality of services offer is poor due to several factors. Therefore, there is urgent need by Nigerian Communication Commission(NCC) to checkmate the activities of these network service providers, in addressing the factors that militating against provision of excellent service to their teaming customers [1]. The investigation and identification of the possible factors and proper solutions through scientific findings became necessary towards solving problems faced by the customers. A research survey conducted by D. A. Shalangwa 2012, through interview with cross section of GSM subscribers within the investigation areas shows there were difficulties experienced by the subscribers of these network service providers. The difficulties experienced by subscribers are; network busy, frequent call drops, an echo, is not available, poor inter and intra connectivity, cross talk interference during conversation and signal fading among others. Factor that affect GSM signal strength within the study area may include snow, fog, rainfall, propagation mechanism such as reflection, refraction, diffraction, scattering, free space loss, foliage and geographical features [2][3]. Wireless radio channels are hard to predict, because mobile radio channels have a random behavior unlike stationary line of sight channels. When considering wireless radio channels there is need to consider all the factors into account that transmission path could be in line of sight or could be obstructed with objects like buildings, mountain etc. when considering the case of wave propagation in urban environment then, we have multiple reflection from high rise buildings and many such types of objects under these circumstances, electromagnetic waves travel through different paths having varying length, when these waves interact at a point, the received signal generates multipath fading, due to these factors, the received waves have varying strengths and also depends on the distance between transmitter and receiver [4]. Therefore, this research is aimed at predicting propagation path loss model for four GSM network service providers within Dutse town in some selected areas.

## **II. Review on Propagation Path Loss Models**

A number of propagation models, both theoretical and empirical, are available to predict path loss

over different types of terrain. However, this study reviews only four models as follows.

**1. Free-Space Propagation Model.**

In free-space, the wave is not reflected or absorbed. Ideal propagation implies equal radiation in all directions from the radiating source and propagation to an infinite distance with no degradation [5]. Free-space attenuation increases as the frequency, (in MHz) goes up for a given unit distance d in (Km). Equation (1) below present the formula to calculate free-space path loss (PL<sub>FS</sub>).[5]

$$PL_{FS(dB)}=32.5+20 \log(d)+20 \log(f).....(1)$$

**2. Keenan-Motley Model**

In contrasts to the losses that account between the medium of transmitter and the receiver there are other losses that play a vital role when focusing on indoor environment such as floor separation and penetration losses due to walls. This is shown in equation (2) below. [6]

$$PL_{FS(d)}=free-space+wallloss.....(2)$$

Therefore, Keenan-Motley Model is given as[6];

$$L_{(dB)}=32.5+20 \log(f)+20 \log(d)+p*w(k)+k*f(k).....(3)$$

**3. Path loss slope model**

Another model used to calculate path loss in indoor environment is the path loss slope. Path loss slope are attenuation slopes that are obtained from different indoor environment by performing large amount of measurements [7][12]. Path loss slope models obey the distance power law model as described in logarithmic distance model below.[7]

$$PL_{(dB)}=PL_{(d_0)}+10n \log(d).....(4)$$

Where, PL(d<sub>0</sub>) is the path loss that is measured at 1Km distance which is given by 32.5 + 20 log(f) + 20 log(d) and n is the path loss slope coefficient.

**4. Log-Normal Shadowing Model**

In terrestrial wireless communication, signal propagation may be characterized by such factors as path loss, shadowing and fading. Path loss has been defined as the attenuation effect on the signal as it propagates from the transmitter to receiver. When the received signal strength gradually varies around its mean value, this phenomenon is called shadowing. While fading describes the frequent fluctuation in the received signal strength due to the arrival of the signal at different time as a result of multipath.

A simple power law path loss model [8] was chosen for predicting the distance over which a reliable communication link can be established between two mobiles. A modified version of the power law path loss model is given by [9].

$$PL_{(di)} = PL_{(do)} + 10n \log\left(\frac{di}{do}\right) + X\sigma \dots \dots \dots (5)$$

$$n = \frac{PL_{(di)} - PL_{(do)}}{10 \log\left(\frac{di}{do}\right)} \dots \dots \dots (6)$$

Where,  $X\sigma$  is a zero-mean Gaussian distributed random variable (in dB) with standard deviation  $\sigma$  (in dB), which attempts to compensate for random shadowing effect where linear regression analysis is been employed, the path loss exponent  $n$ , can be determine (in mean-square error sense) the difference between measured and predicted values of the model yield the equation below given by [8].

$$n = \frac{\sum_{i=1}^N [PLM(di) - PLP(di)]}{\sum_{i=1}^N 10 \log\left(\frac{di}{do}\right)} \dots \dots \dots (7)$$

Where  $PLM(di)$  represent measured path loss and  $PLP(di)$  represent predicted path loss at any distance  $di$ ,  $n$  is the number of the measured data or sample points. The standard deviation is equally minimized as [9].

$$\sigma = \sqrt{\frac{1}{N} \sum [PLM(di) - PLP(di)]^2} \dots \dots \dots (8)$$

Also, received power  $P_r$  in (dBm) at any ‘D’ from the transmitter, with transmit power  $P_t$  in (dBm) is given  $P_r$  (dBm) =  $P_t$  (dBm) -  $P_L$  (dBm)..... (9)

However, for  $100m \leq di \leq 1Km$  using equation.

$$\text{Therefore, } PL_{(di)} = 10 \log\left(\frac{P_t}{P_r}\right) \text{ dB} \dots \dots \dots (10)$$

Recall, path loss exponent indicates the rate at which path loss increases with distance. Path loss can therefore be estimated by using data obtained from field measurements, which are substituted into equation (6).

$$\text{Then, equation (10) becomes: } PL_{(di)} = PL_{(do)} + 10n \log\left(\frac{di}{do}\right) \text{ dB} \dots \dots \dots (11)$$

Where  $PL_{(do)}$  is the reference path loss measured at the reference distance ( $do$ ),  $n$ , is the path loss exponent (usually empirically determine by data obtained from field measurements. It is significant to select a free space reference distance that is appropriate for the propagation environment. In large coverage cellular systems 1km reference distance is commonly used whereas in microcellular systems much smaller distance such as 100m to 1Km are used [10]. The reference distance should always be in the Far field of the antenna so that near field effect do not



'm'	in (dBm)	(dBm)		(dBm)	
100	-50	66	66	0	0
200	-51	67	66+3.01n	1-3.01n	1-6.04n +9.1204n <sup>2</sup>
300	-54	70	66+4.77n	4-4.77n	16-38.16n +22.7529n <sup>2</sup>
400	-57	73	66+6.02n	7-6.02n	49-84.28n +36.2404n <sup>2</sup>
500	-58	74	66+6.99n	8-6.99n	64-111.84n +48.8601n <sup>2</sup>
600	-59	75	66+7.78n	9-7.78n	81-140.04n +60.5284n <sup>2</sup>
700	-62	78	66+8.45n	12-8.45n	144-202.8n +71.4025n <sup>2</sup>
800	-65	81	66+9.03n	15-9.03n	225-270.9n +81.5408n <sup>2</sup>
900	-69	85	66+9.54n	19-9.54n	361-362.5n +91.0116n <sup>2</sup>
1000	-72	88	66+10.00n	22-10.00n	484-440n + 100.00n <sup>2</sup>

Table 1,  $P_{LM}(di)$  was computed from equation (10) and  $P_{LP}(di)$  was computed from equation (11) using  $P_t = \text{antilog}(RSS/10)$ , while the mean square error were determine using equation (12)

$$e(n) = \sum [PLM(di) - PLP(di)]^2 = 524.3969n^2 - 1656.56n + 1425 = 0 \text{ applying equation (13)}$$

$$\frac{\partial e(n)}{\partial n} = 2(524.3969n) - 1656.56 = 0$$

$$N = \frac{1656.56}{1048.7938} = \mathbf{1.6}$$

The standard deviation  $\sigma$  (dB), about a mean value is also evaluated using equation (8)

$$\sigma = \sqrt{1/N \sum [PLM(di) - PLP(di)]^2}$$

$$\sigma = \sqrt{1/10 \sum [524.3969(1.6)^2 - 1656.56(1.6) + 1425]^2} = \mathbf{3.6dB}$$

Substituting for  $P_L(do)$ ,  $n$  and  $\sigma$  to compensate for the error into equation (5) will lead to development of a modified Log-Normal Shadowing Empirical model for Dutse Town and its

environs given by  $P_L(d_i) = 66 + 10(1.6) \log(d_i/d_o) + 3.6$  (dB)

Therefore the resultant path loss model for Dutse town environment is  $P_L(d_i) = 66 + 16 \log(d_i/d_o) \dots \dots \dots (14)$

**V. Result**

The procedure for measurement and derivation carried out leading to the determination of  $P_L(d_o)$ ,  $n$  and  $\sigma$  which result to the development of empirical model of Airtel, were repeated for the remaining network service providers selected for this research. Table 2 below present the result obtained for MTN, Globacom, and Etisalat under the same operating conditions.

Table 2: Reference path loss and standard deviation

Parameter	Airtel	MTN	Globacom	Etisalat
N	1.6	1.7	1.6	2.1
$\sigma$ in (dB)	3.6	3.1	2.4	5.2
Path loss( $d_o$ ) in (dB)	66	60	68	63

The path loss values were substituted into equation (5), and the modified Log-Normal Shadowing model for the respective becomes:

$P_L$  (Airtel) ( $d_i$ ) =  $66 + 10(1.6) \text{Log} (d_i/d_o) + 3.6$  (dB).....(15)

$P_L$  (MTN) ( $d_i$ ) =  $60 + 10(1.7) \text{Log} (d_i/d_o) + 3.1$  (dB) .....(16)

$P_L$  (Globacom) =  $68 + 10(1.6) \text{Log} (d_i/d_o) + 2.4$  (dB) .....(17)

$P_L$  (Etisalat) =  $63 + 10(2.1) \text{Log} (d_i/d_o) + 5.2$  (dB) .....(18)

Hence, equations 15 - 18 above were used to generate the data in Table 3 below. The data presents the measured path losses at different distance for the GSM operators in the study area. It also presents the average path losses for the network services and compares with one another.

Table 3: Measured path losses from the proposed modified model

Distance in (m)	Path loss in (dB) Airtel Network	Path loss in (dB) MTN Network	Path loss in (dB) Globacom Network	Path loss in (dB) Etisalat Network
100	69.60	63.10	70.40	68.20

200	74.42	68.22	75.22	74.52
300	77.23	71.21	78.03	78.22
400	79.23	73.34	80.03	80.84
500	80.78	74.98	81.58	82.88
600	82.05	76.33	82.85	84.54
700	83.12	77.67	83.92	85.95
800	84.05	78.45	84.85	87.16
900	84.87	79.32	85.67	88.24
1000	85.60	80.10	86.40	89.20
<b>Average</b>	<b>80.10</b>	<b>74.27</b>	<b>80.89</b>	<b>82.30</b>

Table 4: Measured and Predicted path losses

	Airtel	MTN	Globacom	Etisalat
Average measured path loss in (db)	75.70	70.20	78.30	76.10
Average predicted path loss in (db)	80.10	74.27	80.89	82.30

Figure 1 and 2 below shows the graphical representations of measured path loss against distance and average measure propagation path loss respectively.

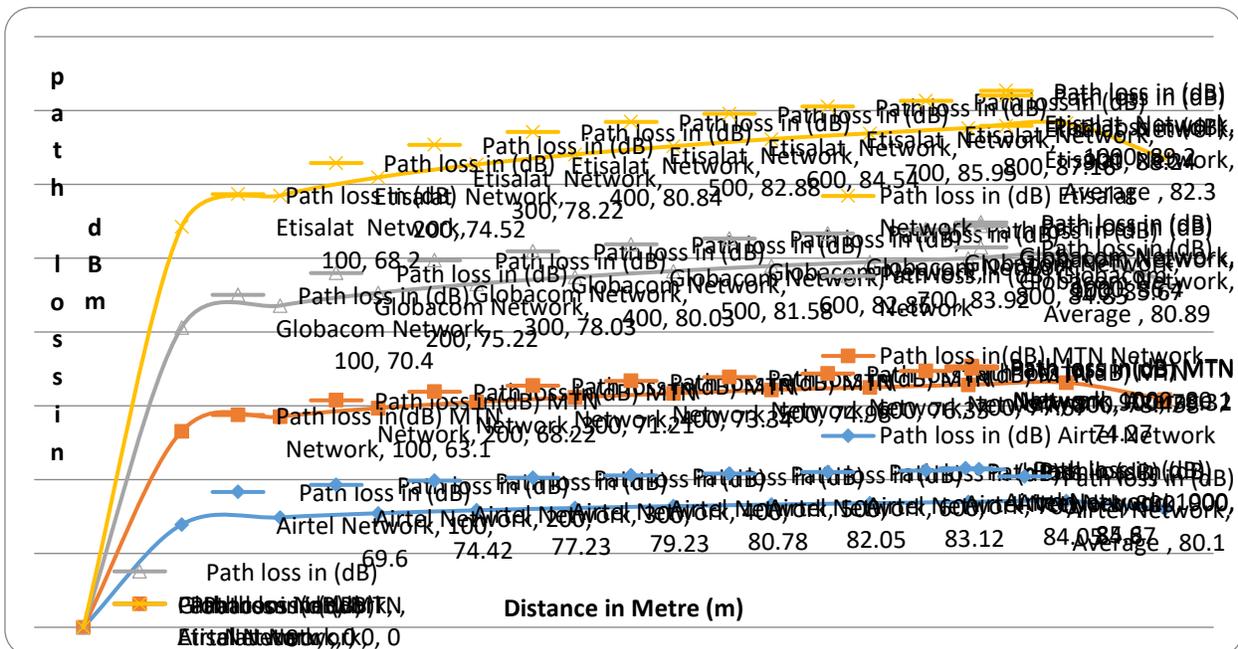


Figure 1: measured path loss against Distance

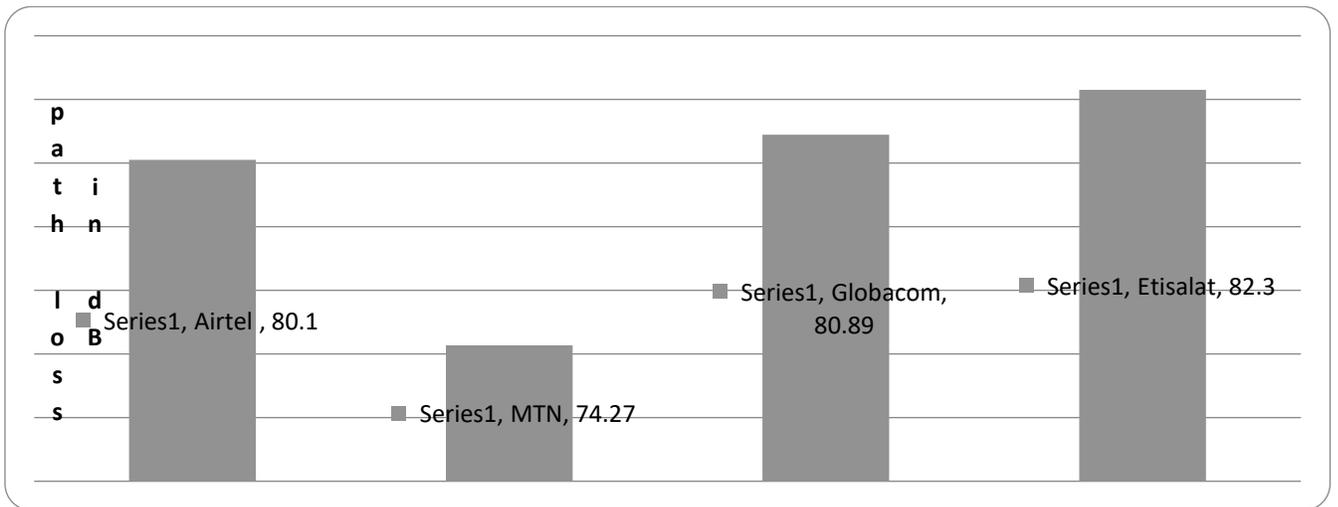


Figure 2: Average measure Propagation Path loss

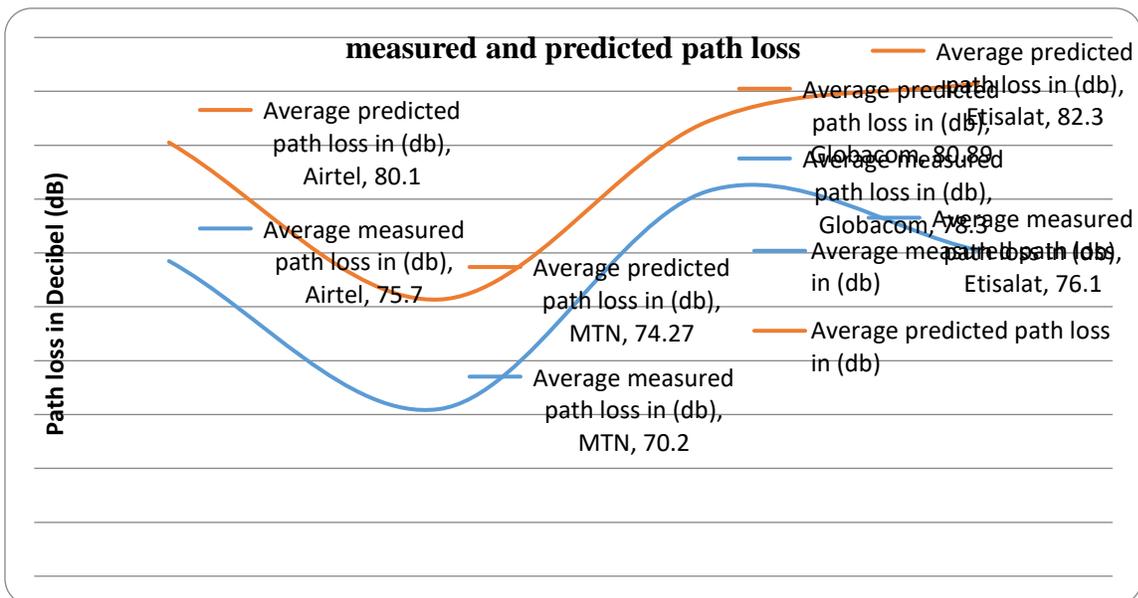


Figure 3: Average measured and predicted path loss

## ***VI Discussion***

Figure 1 presents path loss against distance for the GSM network service providers, considered in this research work. From the result graphically plotted, it shows clearly that path loss for the GSM operators increases at slightly different rates over the measured distance although its values vary from each operator. This is due to the location of the base station or height of the transmitting antenna and the compatibility of the environment, like trees, high rise up buildings and others factors in the area investigated. Figure 2 presents the overall average of propagation path loss measured for GSM operator; Etisalat network has the highest path loss great than that of Airtel, MTN, and Globacom with 8.03dB, 2.59dB and 2.20dB respectively.

## ***VI. Conclusion and Recommendation***

An empirical model was developed for planning and optimizing Global System for Mobile Communication (GSM) networks which addresses poor quality of services provided by GSM service providers in Dutsetown. The average path losses predicted are 80.10dB, 74.27dB, 80.89 and 82.30dB, while the measured are 75.70, 70.20, 78.30 and 76.10 respectively. However, according to R. Rakesh 2012, the acceptable range between measure and predicted result lies between  $1 \leq P_L \leq 20$ dB. Therefore, the variations of the average values obtained lie between 2 to 7dB, which is within the acceptable range. Therefore, it can be concluded that the modified model developed from Log-Normal shadowing model can be useful to GSM network service providers for planning and optimization their services in Dutse, Nigeria. The study recommend that Nigerian Communication Commission (NCC) which is the regulatory body should mandated the GSM service providers in the country to experimentally test their desired scientific model to ascertain its practicability at planning stage before the release of the operating license. Similarly, future studies should test the practicability of three different types of models and compare their suitability at same environment.

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**Does Rhizobial Inoculation Functionality Vary With Host Plant Genotype? A Case Study of Common Bean *Phaseolus vulgaris* L. Germplasms Grown by Smallholder Farmers in Eastern Kenya.**

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**ABSTRACT**

Rhizobia inoculants are soil bacteria that promote biological nitrogen fixation (BNF). Understanding of rhizobia-host genotype association is a critical step in enhancing legume productivity. Questionnaires were used to identify the common bean varieties grown in Eastern Kenya. The native rhizobia were obtained from the root nodules of MAC 13 and MAC 64 bean varieties, which were used for trapping. Afterwards, a greenhouse bioassay was set up in a complete randomized design with three replications. Four weeks later, beans were sampled and examined for nodule number (NNO), nodule dry weight (NDW), shoot dry weight (SDW), root dry weight (RDW), shoot nitrogen (%N) and phosphorus (P). Results demonstrated that highest and significant ( $p < 0.001$ ) NDW, SDW and shoot %N content were achieved in a mix of native consortium+exotic rhizobia (Biofix), while the highest and significant ( $p < 0.001$ ) P content was realized in a consortium of native rhizobia inoculation. Moreover, there was a significant interaction ( $p = 0.001$ ) between rhizobia and bean varieties with Kabuu recording the highest NDW, SDW, %N and P contents in a mix of native consortium+exotic rhizobia. Gacere recorded the highest NDW and SDW when inoculated with exotic rhizobia. Native rhizobia inoculation recorded the highest shoot %N variability in all bean varieties when compared to exotic and a mixture of native+exotic rhizobia. These results show the mutual preference that exists between rhizobia and bean varieties and the multistrain synergism between native and exotic rhizobia. Further studies should explicate the performance of diverse native rhizobia inoculants used in this study under field conditions.

**Key words:** Biological nitrogen fixation, Rhizobia inoculation, Common bean, Eastern Kenya

**XX. Introduction**

Common bean (*Phaseolus vulgaris* L.) is one of the most important nutritious food legumes in the Sub-Saharan Africa (SSA) region (Hillocks, 2011). The crop plays a significant dietary

function of supplying proteins, essential vitamins and carbohydrates to both urban and rural communities (Hamdani and Wani, 2017). According to Thornton *et al.* (2010), the crop is estimated to contribute to more than 50% of the dietary protein to the households in the entire SSA with the annual highest consumption per capita being among the low-income people. The consumption of common beans varies in the different regions of the globe. For instance, in Latin America, the consumption of the crop per capita lies between 4 and 17 kg year<sup>-1</sup> (Leterme and Muñoz, 2002) and corresponds to their production per acreage. Contrarily, in Eastern Africa, the bean consumption per capita is about 50 to 60 kg year<sup>-1</sup> with the consumption of the crop being relatively higher in Kenya, Rwanda, and Uganda (Canfield *et al.*, 2010). Hence, there is a need to enhance the productivity of common beans in Eastern Africa to meet the high consumption demand.

Despite the importance of common bean crop, its yield potential has not yet been maximized especially, in the resource-limited regions such as SSA, where the average production is still less than the consumer demand (National Research Council, 2009). The low yield of common bean in SSA has been associated partly to the low nitrogen and phosphorus content in the soil. Soil acidic conditions exacerbated by phosphorus (P) fixation, aluminum toxicity and drought stress brought by climate change are also to blame (Bekunda *et al.*, 2010). Efforts by the smallholder farmers to enrich soil using synthetic chemical fertilizers has been derailed by the rising cost of living, high cost of farm inputs and limited knowledge on modern agronomic practices (Pretty, 2008).

Common beans in association with plant growth promoting rhizosphere bacteria such as rhizobia carry out a significant role in biological nitrogen fixation (BNF). BNF occurs through a high energy driven complex reaction where nitrogen from the atmosphere is transformed to ammonia by the enzyme known as nitrogenase in the reaction ( $\text{N}_2 + 8\text{H}^+ + 8\text{e}^- \rightarrow 2\text{NH}_3 + \text{H}_2$ ). The reduction of nitrogen into ammonia requires energy in the form of ATP for oxidation of sugars and other compounds (Peters and Boyd, 2015). The host plant through the process of photosynthesis synthesizes carbohydrates that undergo oxidation and are utilized by the bacteria as substrates.

The potential of BNF in enhancing common beans productivity in SSA is limited by unfavorable soil and climatic conditions. Soil pH, insufficient nutrient content, temperature and water stress being the most restraining factors in bean production (Wekesa *et al.*, 2017). Bio-inoculants containing complex formulations of plant growth promoting bacteria have been designed to improve early growth, BNF and plant yields. However, most inoculant formulations contain exotic bacterial isolates, which may not survive or perform efficiently in SSA due to unfavorable edaphic conditions and negative microbial interactions. This necessitates the use of native rhizobia strains well adapted to the local ecological conditions and that are effective in nodulation and N-fixation with different common bean cultivars grown in that particular ecological niche (Sessitschet *et al.*, 2002). Common beans unlike other legumes are poor nitrogen fixers; however, some common bean genotypes and specific rhizobia strains exhibit high potential for N-fixation (Fageria, 2002). In some instances, increasing the diversity of rhizobia strains could enhance N-fixation ability of the plants (Remanset *et al.*, 2008).

Currently, the research and developmental efforts have consistently focused on overcoming the limiting conditions of the production constraints of common bean. The emphasis is mainly focusing on abiotic factors while giving minimal regard to biotic factors like rhizobia bacteria and local bean germplasms, which have a high potential in developing an effective symbiotic nitrogen fixation native rhizobia strains. In addition, rhizobia inoculants can be used to produce ecofriendly bio-fertilizers. Besides, the efficiency of BNF in selected common bean varieties grown in Eastern Kenya has not been evaluated. Interestingly, native rhizobia isolated from the tropical areas of the SSA were found to increase BNF in soil relative to the available commercial exotic strains (Chianuet *et al.*, 2011). According to the study conducted by Overbeck *et al.* (2007), the BNF between the native rhizobia and native legume plants of genus *Desmodium* increased the level of nitrogen in the soil.

A study by Mburu *et al.* (2016) on crop diversity in Eastern Kenya indicated that farmers

maintain a wide diversity of common bean cultivars due to the significant role they play in BNF and food security. Previous research has shown the variability of diverse bean lines to form nodules and fix nitrogen through BNF. For instance, Subbarao *et al.* (1995) and Valentine *et al.* (2010) have reported common bean genetic variability in N-fixation activity as a possible reason explaining why some bean cultivars accumulate high nitrogen contents under water deficit and phosphorus deficient conditions. In this case, it is essential to determine the performance of different common bean cultivars grown by smallholder farmers in regards to nitrogen fixation and their yield potential in different contrasting environments. The bean lines that show high nitrogen fixing potential and improved yield potential could be used for cultivar development.

In this study, we hypothesized that nodulation and BNF effectiveness of a diverse group of native rhizobia, exotic rhizobia (Biofix) and their functionality in promoting BNF vary with bean genotypes grown by smallholder farmers in Eastern Kenya. The specific objectives of this study were; (1) to determine and compare the symbiotic nitrogen fixation effectiveness of native and exotic rhizobia nodulating different common bean varieties grown by smallholder farmers in Eastern Kenya, (2) to determine whether increasing *Rhizobium* isolate diversity would enhance nodulation and nitrogen fixation in common beans, and (3) to determine the effect of rhizobia inoculation on nodulation, growth and shoot nutrition (N and P) content of common bean varieties grown in Eastern Kenya.

## **XXI. Materials and Methods**

### **2.1. Bean variety identification and collection of germplasm**

Ten common bean cultivars were identified by conducting an in-person interview with farmers in Eastern Kenya. Sixty households were interviewed, 32 households in Embu County and 28 in Tharaka Nithi County. The two counties were chosen due to their high production potential of diverse common bean cultivars in both upper and lower midland agro-ecological zones. Based on the interviews, the preferred bean varieties were; Kasango, Mwitmania brown, Mwitmania white, Karoyo, Muviki and Gacere and four non-climbers; Rosecoco, Geturu, Kabuu and Kayiero. Confirmation of these bean varieties was done at Kenya Agricultural Livestock and

Research Organization (KALRO) in Embu, Kenya. A half a kilogram of healthy untreated seeds of each bean variety, kept by the interviewed farmers in the previous season before the interview, were collected randomly for use in the greenhouse bioassays.

## **2.2. Soil characterization and analysis**

Soil samples from four farms; two in each County, were collected before the start of long rainy season of March 2015. The sampling of soil was done on diagonal transects from 20 locations in each of the selected farms by making cores of 5-20 cm deep using a spade. The spade was sterilized before making each core with 5 % sodium hypochlorite solution and then rinsed in three changes of sterile water after which it was dried with a sterile cloth. The soil samples were mixed thoroughly to make a composite sample, which after drying was sieved through a 2 mm diameter strainer to make a homogenous composite soil that was used in the greenhouse. One-kilogram sample of the composite soil was analyzed for soluble salts in the laboratory by use of both physical and chemical methods. Walkley-Black technique was used to establish the carbon content. Both Ca and Mg ions were assessed by the use of atomic absorption spectrophotometry while Bray-I technique was used to determine soil phosphorus (Robert, 1993; Okalebo *et al.*, 2002).

## **2.3. Preparation of yeast mannitol broth**

The yeast mannitol broth was made by combining 1 gram of baker's yeast, 0.5 g  $K_2HPO_4$ , 10 g of Mannitol, 0.2 g  $MgSO_4 \cdot 7H_2O$ , 0.1 grams of NaCl, as well as 1 gram of  $CaCO_3$  so as to give the broth. The ingredients were suspended in a liter of distilled water, heated to boil, and mixed thoroughly. The Yeast Mannitol media were then autoclaved at a temperature of 121 °C and pressure of 15 atmospheres for 15 minutes (Tomaszewska *et al.*, 2012).

## **2.4. Field trap cultures and isolation of native rhizobia**

The trap cultures of native rhizobia were set in four selected farms, with no previous rhizobia inoculation, in both Counties of Embu and Tharaka Nithi using MAC 64 and MAC 13 bean varieties obtained from Kenya Seed Company Limited (Nairobi, Kenya). These two varieties were selected because they are compatible with the native rhizobia in Eastern Kenya (Koskey *et al.*, 2017). Quality seeds of both MAC 13 and MAC 64 were selected and planted in each farm

after tilling. The bean varieties were supplied with phosphorus by applying Triple Superphosphate (46.0% P<sub>2</sub>O<sub>5</sub>) fertilizer at a rate of 50 kg ha<sup>-1</sup>. Thirty days after emerging, ten bean plants from each farm were randomly sampled and harvested by making a 15 cm radius circle around the plant with a cut out section of 20 cm deep using a spade. The clump was then lifted slowly and soil carefully removed from the plant roots. The root nodules were detached and washed in sterile water to remove soil particles. Nodules were packed in sampling vials containing desiccated silica gel and cotton wool and transported to the Microbiology Research Laboratory at Kenyatta University, Nairobi, Kenya, for isolation of rhizobia.

In the laboratory, rhizobia were isolated from the root nodules following the procedures described by Somasegaran and Hoben (1994). Nodules were surface sterilized by wrapping them in a muslin cloth containing 90% alcohol for 1 minute. The nodules were then thoroughly washed using six changes of sterilized water after which the small roots were removed. The obtained nodules were crushed using a sterile glass rod in a watch glass containing 0.5 ml of sterile water. To ensure that proper sterilization was performed, the plates containing Yeast Extract Mannitol Agar (YEMA) complemented with Congo red (CR) were used to test the sterility (Vincent, 1970). One plate was streaked with a loop full of sterile water (control), the second plate was streaked with water used for the sixth change of the root nodules and the third plate was streaked by a loop full of the nodule exudates. The plates that had colonies were picked and subjected to further purification. If a culture had many colonies, the colonies were aseptically transferred to separate plates of YEMA-CR and treated as separate isolates.

## **2.5. Verification of isolated rhizobia**

Typical rhizobia were recognized by cultural and morphological appearance, Gram staining, biochemical tests such as the production of acidity or alkalinity in YEMA with Bromothymol blue and growth on peptone glucose agar (Vincent, 1970). Gram staining was carried out following the procedures outlined by Claus (1992). The identity of rhizobia was recognized by weak absorption of the Congo-red dye, a characteristic that is not found in any other agrobacteria. Other distinct features such as colony shape, elevation, margin, exo-polysaccharide (EPS) production were used to identify rhizobia (Maingi *et al.*, 2001). Upon using YEMA supplemented with Bromothymol blue indicator, production of yellow coloration was detected,

an indication of fast growing acidifying rhizobia bacteria (Workalemahu and Assefa, 2007). In the last method, rhizobia bacteria were cultured in plates containing peptone glucose agar, then incubated at 28 °C for 48 hours. The absence of bacteria growth was a clear indication of the presence of *Rhizobium* bacteria (Hotter and Scott, 1991). Based on morpho-cultural and biochemical features, the native rhizobia isolates were grouped in to nine distinct morphotypes. Verification of isolates used in this study as rhizobia bacteria was based on the descriptions outlined by Somasegaran and Hoben (1994).

## **2.6. Rhizobia inoculum preparation**

Nine pure isolates of native rhizobia (obtained from each distinct morphotype group), exotic rhizobia (Biofix) and a mix of all the nine native isolates and exotic rhizobia were aseptically transferred into three different identical conical flasks containing 100 ml of YEM broth. The consortium of native rhizobia was prepared by mixing all the nine native isolates in equal volumes of 1 ml each. Similarly, a mixture of native consortium and exotic isolates were prepared by mixing an already prepared consortium of native rhizobia with the exotic isolates in equal volume ratio of 1:1. The rhizobia isolates were then incubated in a rotary shaker at 28 °C, 7 days prior to planting. After 5 days of incubation, the bacteria isolates revealed moderate turbidity in YEMB a clear characteristic of viable rhizobia (Workalemahu and Assefa, 2007).

## **2.7. Greenhouse bioassays**

### **2.7.1. Experimental design**

The greenhouse experiment was set using a completely randomized design (CRD) with 10 common bean varieties as the main treatments and four rhizobia inoculants as the sub-treatments. The ten bean varieties included Kabuu, Gacere, Geturu, Muviki, Mwitmania brown, Mwitmania white, Kasango, Kayiero, Karoyo and Rose coco. Rhizobia inoculants included a consortium of native rhizobia (NTV), exotic rhizobia (EXT) - Biofix from MEA limited, Nakuru, Kenya, and a mix of native consortium + exotic rhizobia (MIX).

### **2.7.2. Soil sterilization, seed preparation and pre-germination**

A kilogram of homogenously mixed soil (section 2.2) containing sand (1:1 by volume) was sterilized and aseptically transferred to sterile pots. Uniform seeds of the ten common bean

varieties were surface disinfected by submerging them in 95% ethanol for 15 seconds to eliminate air and waxy material after which they were submerged in a sterile flask containing 3 % NaClO for 3 minutes. The seeds were then washed in six changes of sterile water. The bean seeds were left in the last change of sterile water for four hours until they were completely soaked up. The bean seeds were again washed in two changes of sterile water. A short time later, they were aseptically transferred with a sterilized forceps onto the surface of a 2 % water agar petri-dish and incubated at a constant temperature of 25 °C until they developed a radical of about 1 cm long (Elfeel, 2012).

### **2.7.3. Planting and inoculation of the seedlings**

Three holes were made in the soil medium each one centimeter deep. The water agar pre-germinated seedlings were aseptically picked with a sterilized forceps and sown one seed for every hole. After 5 days of planting, the young seedlings were thinned to two uniform plants per pot and inoculated with an exact quantity of 1 ml of broth having  $10^9$  *Rhizobium* microbes using a micro-pipette. The seedlings were inoculated with a consortium of native rhizobia (NTV), exotic strain (EXT), a mix of native + exotic rhizobia (MIX), and a control, with no rhizobia inoculation (CONTROL). Each treatment was then replicated 3 times with 2 plants in each pot.

### **2.7.4. Crop maintenance and harvesting**

Plants were irrigated 2 times a week with sterile water until sampling time. Throughout this time, the plant growth and leaf color were frequently noted for any abnormality. During the study period, the highest daytime temperature recorded was 30 °C while the lowest was 24 °C. After 28 days, the three replicates of bean varieties from each treatment were randomly selected, removed from pots and separated into shoots, roots, and nodules with each treatment being kept in separate sampling bags. The sampled plants were then dried in an oven at a temperature of 70 °C until a constant weight was attained. The shoot samples were then analyzed for nitrogen (N) and phosphorus (P) (Jensen *et al.*, 2010).

## **2.8. Biomass measurements and determination of shoot nutrients (N and P) content**

The dry weights of roots, nodules and shoots were measured and recorded using digital weighing balance. Kjeldahl procedure was used to determine shoot nitrogen (%N) content (Justes *et al.*,

1994). Shoot phosphorus was determined by using colorimetric and photometric procedure, which involved sulphuric-perchloric acid digestion (Leidi and Rodriguez-Navarro, 2000).

## **2.9. Data analyses**

The greenhouse data were tested for homogeneity of variance using Bartlett test before analyses. The percentage data were arcsine ( $\sqrt{x}$ ) transformed, whereas other data were  $\log(x+1)$  transformed wherever it was necessary to achieve the expectations of ANOVA. The data reported in tables and graphs was as well back transformed. Two-way ANOVA was used to analyze data obtained from the greenhouse experiment based on a completely randomized design. Pearson correlation coefficient was used to find out the relationship between growth parameters and nitrogen fixation. Wherever applicable, post hoc test was executed using Tukey's HSD test ( $P < 0.05$ ). All statistical analyses were performed using the general linear model (GLM) procedure of the Statistical Analysis System (version 9.0) (SAS Institute Inc., Cary, NC, USA).

## **XXII. Results**

The soil used in the greenhouse experiment were slightly acidic with a pH of 5.93 (Table 1). The soil had moderate amounts of organic carbon (2.8%), total nitrogen (0.24%), potassium (2.7 cmol/kg) and calcium ions (9.1 cmol/kg). The available phosphorus and magnesium ions were slightly higher above the critical limits described by Okalebo *et al.* (2002). The soil texture was sandy clay loam (Table 1).

Forty-one isolates of nodule occupants with morphological, cultural and biochemical characteristics of common bean rhizobia as described by Herridge (1982) and Somasegaran and Hoben (1994) were isolated from MAC 13 and MAC 64 bean varieties. The 41 isolates were grouped into nine distinct morphotypes based on their morpho-cultural and biochemical features. All the isolates were Gram-negative rods, fast growers and turned YEMA-BTB from green to yellow. The isolates did not absorb Congo red dye upon culturing in YEMA-CR media and did not show any growth in peptone-glucose agar media. The isolates showed varied morpho-cultural features including exhibiting white, milky, creamy, firm gummy, soft gummy or watery colonies with domed, convex or raised elevations.

From the greenhouse bioassays, inoculation with a mixture of native and exotic rhizobia isolates significantly ( $P < 0.001$ ) enhanced common bean nodulation, recording the highest NNO ( $68.87 \pm 6.28 \text{ plant}^{-1}$ ) and NDW ( $0.0835 \pm 0.007 \text{ g plant}^{-1}$ ) (Table 2). Bean inoculation with a consortium of native rhizobia performed relatively better recording an average of  $58.73 \pm 6.18 \text{ g plant}^{-1}$  and NDW of  $0.0603 \pm 0.006 \text{ g plant}^{-1}$  compared to the inoculation with exotic rhizobia alone which recorded an average of  $44.20 \pm 4.65 \text{ nodules plant}^{-1}$  and NDW of  $0.0484 \pm 0.005 \text{ g plant}^{-1}$ . There was a significant ( $P < 0.001$ ) nodulation difference observed across the ten bean varieties with Kabuu bean variety recording the highest NNO and NDW ( $74.42 \pm 14.94 \text{ plant}^{-1}$ ,  $0.0757 \pm 0.014 \text{ g plant}^{-1}$  respectively) while Rose cocoa recorded the lowest NNO and NDW ( $17.83 \pm 4.54 \text{ plant}^{-1}$ ,  $0.0218 \pm 0.006 \text{ g plant}^{-1}$  respectively). As expected, the controls without rhizobia inoculation did not show any nodulation. A significant ( $P = 0.001$ ) interaction between rhizobia isolate inoculation and common bean variety was shown with Kabuu bean variety recording the highest nodulation (NDW= $0.126 \pm 0.086 \text{ g plant}^{-1}$ ) when inoculated with a mixture of native + exotic rhizobia (Figure 1). Gacere bean variety recorded the highest NDW when inoculated with native rhizobia ( $0.121 \pm 0.019 \text{ g plant}^{-1}$ ) and exotic rhizobia ( $0.100 \pm 0.005 \text{ g plant}^{-1}$ ).

There was a significant ( $P < 0.001$ ) difference in shoot dry weight (SDW) of the common bean varieties tested upon inoculation with rhizobia, with a mixture of native consortium + exotic rhizobia recording the highest SDW ( $2.365 \pm 0.089 \text{ g plant}^{-1}$ ) when compared with exotic ( $2.082 \pm 0.068 \text{ g plant}^{-1}$ ) and native rhizobia ( $2.146 \pm 0.079 \text{ g plant}^{-1}$ ) inoculations (Table 2). The control, with no rhizobia inoculation, was the least, producing an average SDW of  $1.666 \pm 0.048 \text{ g plant}^{-1}$ . There was a significant ( $P < 0.001$ ) SDW difference observed across the ten bean varieties with Kabuu recording the highest SDW at an average of  $2.715 \pm 0.159 \text{ g plant}^{-1}$  while Kayiero had the least SDW at an average of  $1.765 \pm 0.114 \text{ g plant}^{-1}$ . A significant ( $P = 0.001$ ) interaction between rhizobia inoculation and common bean varieties was shown with Kabuu producing the highest SDW in a mix of native + exotic rhizobia ( $3.257 \pm 0.014 \text{ g plant}^{-1}$ ) (Figure 2). There was a significant ( $P < 0.001$ ) difference in RDW of the ten bean varieties with Muviki recording the highest RDW of  $0.721 \pm 0.0614 \text{ g plant}^{-1}$ , while Mwitmania white recorded the lowest RDW with an average of  $0.401 \pm 0.0558 \text{ g plant}^{-1}$  (Table 2).

Results of shoot nitrogen indicated that different rhizobia isolates significantly ( $P < 0.001$ ) enhanced shoot nitrogen in inoculated common beans when compared with the un-inoculated controls (Table 3). The multi-strain mixture of both native consortium + exotic rhizobia recorded the highest shoot nitrogen at an average of  $3.398 \pm 0.08$  percent; the least shoot percentage nitrogen was recorded by the un-inoculated controls at an average of  $2.114 \pm 0.06$  percent. Likewise, a significant difference ( $P < 0.001$ ) in percentage shoot nitrogen of bean varieties tested was revealed with Kabuu bean variety producing the highest percentage nitrogen at an average of  $3.216 \pm 0.20$  percent (Table 3). Kayiero produced the least shoot percentage nitrogen at an average of  $2.187 \pm 0.12$  percent. Moreover, there was a significant ( $P = 0.006$ ) interaction between rhizobia inoculation and bean varieties with Kabuu recording the highest percentage nitrogen ( $3.973 \pm 0.067$  g plant<sup>-1</sup>) in a mixture of both the native consortium + exotic rhizobia (Figure 3). Muviki bean variety recorded the highest percentage nitrogen ( $3.753 \pm 0.090$  g plant<sup>-1</sup>) when inoculated with native rhizobia, while Gacere bean variety recorded the highest percentage nitrogen ( $2.863 \pm 0.071$  g plant<sup>-1</sup>) when inoculated with exotic rhizobia.

Rhizobia inoculation with different isolates revealed a significant difference ( $P < 0.001$ ) in shoot phosphorus compared to un-inoculated controls with native rhizobia showing the highest amount of shoot phosphorus at an average of  $9293.70 \pm 291.12$  ppm (Table 3). Inoculation with a mixture of native consortium + exotic rhizobia recorded an average of  $9000.13 \pm 288.92$  ppm while exotic rhizobia showed an average shoot phosphorus of  $8704.27 \pm 196$  ppm. A significant difference ( $P < 0.001$ ) was also revealed among the ten bean varieties with Kabuu recording the highest amount of shoot phosphorus at an average of  $11740.92 \pm 671.99$  ppm. The least amount of shoot phosphorus was recorded in Kayiero with an average of  $6654.25 \pm 219.27$  ppm (Table 3). In addition, there was a significant ( $P = 0.003$ ) interaction between rhizobia inoculation and bean varieties with Kabuu bean variety recording the highest amount of shoot phosphorus in a mixture of both the native consortium + exotic rhizobia ( $14635.33 \pm 19.33$  g plant<sup>-1</sup>) and when inoculated with exotic rhizobia ( $10685 \pm 15.81$  g plant<sup>-1</sup>) (Figure 4). Muviki bean variety recorded the highest amount of shoot phosphorus ( $12816.67 \pm 17.93$  g plant<sup>-1</sup>) when inoculated with native rhizobia.

The analysis on the relative increase in shoot dry weight (SDW) as influenced by different

rhizobia inoculants revealed a significant difference ( $P < 0.001$ ) among the ten common bean genotypes (Figure 5). However, the relative increase in SDW of Geturu and Karoyo varieties was non-significant ( $P = 0.09$ ) compared to that of other varieties upon inoculation with all the rhizobia inoculants. Similarly, the relative increase in SDW of Kabuu variety was non-significant ( $P = 0.106$ ) compared to that of other varieties upon inoculation with exotic rhizobia inoculant (Figure 5).

The shoot nitrogen analysis of different bean varieties revealed a significant difference ( $P < 0.001$ ) upon rhizobia inoculation when compared to the non-inoculated controls (Figure 6). There was a greater shoot percentage nitrogen variability observed in most of the bean varieties inoculated with native rhizobia when compared to those inoculated with exotic and a mixture of native and exotic rhizobia. The ten bean varieties produced the highest relative increase in percentage nitrogen content due to inoculation with a mixture of both native consortium + exotic rhizobia while the least relative increase in percentage nitrogen was observed in exotic rhizobia inoculation (Figure 6).

Finally, there was a positive and a significant correlation ( $R^2 = 0.7361$ ,  $P < 0.0001$ ) between nodule dry weight and shoot dry weight where an increase in nodule dry weight resulted to an increase in shoot dry weight (Figure 7). Similarly, a positive and a significant correlation ( $R^2 = 0.4702$ ,  $P < 0.0001$ ) between nodule dry weight and percentage nitrogen was observed (Figure 8).

### **XXIII. Discussion**

The physico-chemical analysis revealed that the soil from Eastern Kenya was slightly acidic and rich in phosphorus content. Phosphorus is crucial to proper development of leaves and dry matter in legumes. The slightly acidic nature of the soil could interfere with the maximal functioning of nitrogen-fixing rhizobia strains. Kawaka *et al.* (2014) suggests that bean plants require neutral soil for appropriate growth especially when they rely exclusively on symbiotic nitrogen fixation for nitrogen acquisition. The presence of microelements such as calcium and magnesium in the soil used in this study is an indication that the soil were suitable for use in the greenhouse since most plant tissues require micro-nutrients for their development (Hart *et al.*, 2003).

Generally, the morpho-cultural, biochemical and other phenotypic properties of the 41 rhizobia isolates obtained from the field trapping using MAC 13 and MAC 64 climbing bean varieties showed a large variation and grouped into nine distinct morphotypes. The morpho-cultural, biochemical and Gram staining characteristics confirmed the isolates used in this study as common bean rhizobia as described by Somasegaran and Hoben (1994), Hungria (2000) and Kawaka *et al.* (2014).

From the greenhouse study, the inoculation of different common bean cultivars with a multi-strain mixture of both native consortium and exotic rhizobia revealed a significant increase in bean nodulation, shoot biomass and N-fixation. This could be attributed to the multi-strain synergistic effect caused by the diverse strains of native and exotic rhizobia applied to the beans during inoculation. A proper combination of different infective and effective *Rhizobium* strains enhances nodule occupancy, biological fixation of nitrogen and common bean development. These results are similar to those of Hungria *et al.* (2000) who noted that a combination of specific rhizobia strains, which are well adapted to the local ecological conditions, performs better in promoting N-fixation and growth of different bean cultivars as compared to the use of individual rhizobia strains.

Among the ten common bean genotypes studied, inoculation with a mixture of both native consortium + exotic rhizobia produced the highest NDW in Kabuu bean variety, while inoculation with exotic rhizobia produced the highest NDW in Gacere bean variety. This NDW variability as influenced by different rhizobia inoculations could be associated with the fact that there exists rhizobia-bean preference. This could further relate to the genetic variability and the type of exudates that the plant produce to attract a specific rhizobia. These results relate to that of Triplett and Sadowsky (1992) and Mhamdi *et al.* (2002), who found that different bean genotypes prefer certain rhizobia strains for nodulation and nitrogen fixation. Notably, bean inoculation with the consortium of native rhizobia showed a significant increase in root nodulation producing a relatively higher NDW than that of exotic strains. This could be because native rhizobia are well adapted to the local agro-climatic and edaphic conditions and moreover, native rhizobia have developed a long-term symbiotic association with the existing native bean plants. These results relate to the work done by Romdhane *et al.* (2007) who found out that native rhizobia are well

adapted to the native bean genotypes and can compete more effectively in root colonization when compared to the exotic rhizobia strains.

For shoot dry weight, all rhizobia inoculations revealed a significant difference with a combination of native consortium + exotic rhizobia producing the highest SDW and this was likely because of the synergistic effects of native and exotic rhizobia isolates in symbiotic nitrogen fixation. Common bean (*Phaseolus vulgaris* L.) is a non-selective plant host and can perceive signals for nodulation from different strains of homologous and non-homologous rhizobia and this may promote nitrogen fixation, plant growth and development (Mitchell-Olds *et al.*, 1998). These findings relate to the study carried out by Zablutowicz *et al.* (1991) who found that increasing rhizobia diversity enhances shoot dry weight in bean plants. There was significant SDW differences observed across the ten bean varieties and upon inoculation with the three rhizobia inoculants. Additionally, due to the interaction between bean varieties and rhizobia inoculation, Kabuu variety recorded the highest SDW upon inoculation with a mixture of native + exotic rhizobia. Inoculation with exotic rhizobia produced the highest SDW in Gacere bean variety. These results could suggest that increasing rhizobia diversity increases SDW of bean plants. Interestingly, in some bean varieties such as Gacere and Geturu, inoculation with native rhizobia was not as efficient in shoot biomass accumulation as that of exotic rhizobia and thus there could be a need to introduce other compatible rhizobia strains for maximum bean development to be achieved. In support of this, Hungria *et al.* (2003) observed that for high shoot dry weight to be achieved in bean plants, proper combination of *Rhizobium* strains has to be identified to enhance more competitiveness in nodule occupancy, nitrogen fixation and production of shoot biomass. The root biomass of the ten bean varieties varied significantly. The difference could be attributed to the bean genotype, which could affect root development (Aguilar *et al.*, 2001). On the other hand, rhizobia inoculation did not significantly affect the RDW of the 10 bean varieties studied. These findings are similar to those reported by Koskey *et al.* (2017) who reported non-significant difference in RDW of MAC 13 and MAC 64 climbing beans inoculated with different rhizobia isolates.

Shoot nitrogen analysis revealed that all rhizobia inoculants enhanced significantly the shoot nitrogen when compared with the non-inoculated controls, with the combination of native

consortium + exotic rhizobia producing the highest percentage nitrogen due to the multi-strain synergism between the native and exotic rhizobia. This result suggests that an increase in rhizobia diversity could enhance the shoot percentage nitrogen. This also indicates that to achieve higher shoot nitrogen content in common bean, the use of native rhizobia alone may not be satisfactorily effective and thus there is a necessity to introduce other effective rhizobia strains that could offer synergistic benefits to the plants. This study relates to the work done by Maingi *et al.* (2001) who observed that for high shoot nitrogen content in bean plants to be achieved, proper combination of *Rhizobium* strains have to be identified to enhance more effective fixation of nitrogen. Similarly, a significant difference in percentage shoot nitrogen of bean varieties tested revealed that Kabuu variety recorded the highest percentage nitrogen while Kayiero produced the least shoot percentage nitrogen. This variation in percentage nitrogen accumulation in plant shoots could be explained by the genetic variation of the beans, which indirectly affects the symbiotic association with the rhizobia bacteria found in the plant rhizosphere. This relates to the work done by Ramaekers *et al.* (2010) who noted that for high shoot nitrogen content to be accumulated by the bean plants, compatible bean varieties and effective *Rhizobium* strains have to be identified.

The relative increase in SDW and shoot percentage nitrogen of the ten bean varieties as influenced by the three rhizobia inoculants varied significantly. Bean genetic variation and the difference in chemical exudates signalling rhizobia during root infection could affect bean-rhizobia compatibility and consequently affecting the performance of BNF process (Ramaekers *et al.*, 2010). A greater shoot percentage nitrogen variability observed in most of the bean varieties inoculated with native rhizobia could be explained by the fact that native rhizobia are well adapted to the local edaphic conditions and have developed a long term symbiotic association with the existing local bean varieties.

The positive and significant associations between NDW and SDW, NDW and shoot nitrogen confirms the dependence of bean shoot biomass accumulation and nitrogen fixation on nodulation. These results support the assertions made by Kawaka *et al.* (2014) and Koskey *et al.* (2017), that there is a direct association among nodulation, plant growth and nitrogen accumulation in legume plants.

The shoot phosphorus analysis showed that all plants inoculated with rhizobia showed a significant increase with native rhizobia producing the highest phosphorus content. These findings are similar to the study by Neila *et al.* (2012) who observed that native rhizobia increase shoot phosphorus in bean plants. Native rhizobia together with other localized plant growth promoting bacteria are known to form synergistic associations that would lead to phosphate solubilization in the soil and hence availing phosphorus for plant uptake (Leidi and Rodriguez-Navarro, 2000). Among the bean genotypes, Kabuu bean variety accumulated the highest shoot phosphorus content upon inoculation with all the three rhizobia inoculants. This result suggests that specific bean varieties respond well to rhizobia inoculants regardless of the diversity and hence such varieties are suitable for cultivation. Therefore, for higher shoot phosphorus content to be achieved in common beans, variety response against inoculants should be screened and compatible genotypes should be identified. Ramaekers *et al.* (2010) observed that for high shoot phosphorus content in bean plants to be achieved, compatible bean varieties and effective *Rhizobium* strains have to be identified.

#### **XXIV. Conclusion**

In this study, it was established that Kabuu bean variety responded better to inoculation than any other bean varieties. Kabuu bean variety should therefore be considered for further screening for other beneficial properties such as yield in different agroecological zones in Kenya. The rhizobia inoculation functionality varied significantly in nodulation, plant growth parameters and nitrogen fixation with the ten common bean varieties tested in the greenhouse. It was evident that a mixture of the consortium of native + exotic rhizobia enhanced nodulation, shoot biomass and shoot percentage nitrogen content in common bean varieties grown by smallholder farmers in Eastern Kenya. Thus, diversification of rhizobia isolates should be considered when developing affordable rhizobia biofertilizer inoculants for use by resource limited smallholder farmers in bean production. These results demonstrate a key performance of different common bean varieties grown by smallholder farmers in regard to nitrogen fixation and form an important step towards the selection and development of bean cultivars with high biological nitrogen fixation potential. Further studies should elucidate the performance of the various rhizobia inoculants used here under field conditions.

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### Figure legends

**Figure 1:** Interactive effects of bean variety with rhizobia inoculants on nodule dry weight. Bars followed by the same letters within the same group are not significantly different according to Tukey's HSD test at  $P \leq 0.05$ . KEY: NDW, Nodule dry weight; MIX, Combination of native and exotic rhizobia; EXT, Exotic rhizobia; NTV, Native rhizobia; KABU, Kabuu; GACE, Gacere; GETU, Geturu; MUVI, Muviki; MBRN, Mwitmania brown; MWHT, Mwitmania white; KASA, Kasango; KAYI, Kayiero; KARO, Karoyo; ROSE, Rose cocoa

**Figure 2:** Interactive effects of bean variety with rhizobia inoculants on shoot dry weight. Bars followed by the same letters within the same group are not significantly different according to Tukey's HSD test at  $P \leq 0.05$ . KEY: SDW, Shoot dry weight; MIX, Combination of native and exotic rhizobia; EXT, Exotic rhizobia; NTV, Native rhizobia; KABU, Kabuu; GACE, Gacere; GETU, Geturu; MUVI, Muviki; MBRN, Mwitmania brown; MWHT, Mwitmania white; KASA, Kasango; KAYI, Kayiero; KARO, Karoyo; ROSE, Rose cocoa

**Figure 3:** Interactive effects of bean variety with rhizobia inoculants on shoot percentage nitrogen. Bars followed by the same letters within the same group are not significantly different according to Tukey's HSD test at  $P \leq 0.05$ . KEY: MIX, Combination of native and exotic rhizobia; EXT, Exotic rhizobia; NTV, Native rhizobia; KABU, Kabuu; GACE, Gacere; GETU, Geturu; MUVI, Muviki; MBRN, Mwitmania brown; MWHT, Mwitmania white; KASA, Kasango; KAYI, Kayiero; KARO, Karoyo; ROSE, Rose cocoa

**Figure 4:** Interactive effects of bean variety with rhizobia inoculants on shoot phosphorus. Bars followed by the same letters within the same group are not significantly different according to Tukey's HSD test at  $P \leq 0.05$ . KEY: MIX, Combination of native and exotic rhizobia; EXT, Exotic rhizobia; NTV, Native rhizobia; KABU, Kabuu; GACE, Gacere; GETU, Geturu; MUVI, Muviki; MBRN, Mwitmania brown; MWHT, Mwitmania white; KASA, Kasango; KAYI, Kayiero; KARO, Karoyo; ROSE, Rose cocoa

**Figure 5:** Relative increase in SDW of bean varieties inoculated with native, native + exotic, and exotic rhizobia. \* indicates SDW changes under certain treatments is significant from control at  $P < 0.05$  (Tukey's HSD test). ns indicates no significant difference from the control. KABU, Kabuu; GACE, Gacere; GETU, Geturu; MUVI, Muviki; MBRN, Mwitmania brown; MWHT, Mwitmania white; KASA, Kasango; KAYI, Kayiero; KARO, Karoyo; ROSE, Rose cocoa

**Figure 6:** Relative increase in shoot percentage nitrogen of bean varieties inoculated with native, native + exotic, and exotic rhizobia. \* indicates shoot percentage nitrogen changes under certain treatments is significant from the control at  $P < 0.05$  (Tukey's HSD test). KABU, Kabuu; GACE, Gacere; GETU, Geturu; MUVI, Muviki; MBRN, Mwitmania brown; MWHT, Mwitmania white; KASA, Kasango; KAYI, Kayiero; KARO, Karoyo; ROSE, Rose cocoa

**Figure 7:** Relationship between NDW and SDW following rhizobia inoculation of common bean varieties grown in Eastern Kenya.

**Figure 8:** Relationship between NDW and %N following rhizobia inoculation of common bean varieties grown in Eastern Kenya.

## Tables

**Table 1:** Soil pH and nutrients

Sample Description	pH	% N	% OC	cmol/kg			P (ppm)
				K	Ca	Mg	
Soil	5.93	0.24	2.8	2.7	9.1	3.65	143.5
Nutrient level	Low	Mod	Mod	Mod	Mod	High	High

**Table 2:** Two-way-ANOVA (mean  $\pm$  SE) for nodule number (NNO), nodule dry weight (NDW), shoot dry weight (SDW), and root dry weight (RDW) as affected by rhizobia inoculation and common bean variety. Means within a column followed by different letter(s) are statistically different (Tukey's HSD test at  $P < 0.05$ )

<b>Rhizobia inoculation</b>	<b>NNO</b>	<b>NDW(g)</b>	<b>SDW(g)</b>	<b>RDW(g)</b>
MIX	68.87 $\pm$ 6.28a	0.0835 $\pm$ 0.007a	2.365 $\pm$ 0.089a	0.5734 $\pm$ 0.0353a
EXT	44.20 $\pm$ 4.65c	0.0484 $\pm$ 0.005c	2.082 $\pm$ 0.068b	0.5668 $\pm$ 0.0398a
NTV	58.73 $\pm$ 6.18b	0.0603 $\pm$ 0.006b	2.146 $\pm$ 0.079b	0.5340 $\pm$ 0.0432a
CONTROL	-	-	1.666 $\pm$ 0.048c	0.5234 $\pm$ 0.0413a
<b>Variety</b>				
KABU	74.42 $\pm$ 14.94a	0.0757 $\pm$ 0.014a	2.715 $\pm$ 0.159a	0.682 $\pm$ 0.0304ab
GACE <sup>•</sup>	58.25 $\pm$ 13.32b	0.0691 $\pm$ 0.015a	2.581 $\pm$ 0.138ab	0.554 $\pm$ 0.0565bc
GETU	54.08 $\pm$ 10.47b	0.0526 $\pm$ 0.011b	1.932 $\pm$ 0.073bc	0.535 $\pm$ 0.0722cd
MUVI <sup>•</sup>	49.17 $\pm$ 12.86bc	0.0522 $\pm$ 0.015b	2.074 $\pm$ 0.106b	0.721 $\pm$ 0.0614a
MBRN <sup>•</sup>	39.58 $\pm$ 7.24cd	0.0455 $\pm$ 0.008bc	1.849 $\pm$ 0.108cd	0.443 $\pm$ 0.0574cd
MWHT <sup>•</sup>	37.92 $\pm$ 9.56cd	0.0438 $\pm$ 0.013bc	1.942 $\pm$ 0.062bc	0.401 $\pm$ 0.0558d
KASA <sup>•</sup>	36.58 $\pm$ 8.49d	0.0417 $\pm$ 0.009bc	2.085 $\pm$ 0.115b	0.466 $\pm$ 0.0349cd
KAYI	33.50 $\pm$ 9.61d	0.0421 $\pm$ 0.011bc	1.765 $\pm$ 0.114d	0.462 $\pm$ 0.0318cd
KARO <sup>•</sup>	28.17 $\pm$ 7.78de	0.0359 $\pm$ 0.009c	1.843 $\pm$ 0.062cd	0.415 $\pm$ 0.0435cd
ROSE	17.83 $\pm$ 4.54e	0.0218 $\pm$ 0.006d	1.859 $\pm$ 0.082cd	0.816 $\pm$ 0.0486a
<b>P value for the main treatments and their interaction</b>				

Rhizobial inoculation	<0.001	<0.001	<0.001	0.644
Variety	<0.001	<0.001	<0.001	<0.001
Rhizobial inoculation x Variety	0.001	0.001	0.001	0.473

KEY: MIX, combination of native and exotic rhizobia; EXT, exotic rhizobia; NTV, native rhizobia; KABU, Kabuu; GACE, Gacere; GETU, Geturu; MUVI, Muviki; MBRN, Mwitmania brown; MWHT, Mwitmania white; KASA, Kasango; KAYI, Kayiero; KARO, Karoyo; ROSE, Rosecoco; ●, Climber beans.

**Table 3:** Two-way-ANOVA (mean  $\pm$  SE) for percent shoot nitrogen (%N) and phosphorus (ppm P) as affected by rhizobia inoculation and common bean variety. Means within a column followed by different letter(s) are statistically different (Tukey's HSD test at  $P<0.05$ )

<b>Rhizobia inoculation</b>	<b>N (%)</b>	<b>P (ppm)</b>
MIX	3.398 $\pm$ 0.08a	9000.13 $\pm$ 288.92ab
NTV	2.811 $\pm$ 0.11b	9293.70 $\pm$ 291.12a

EXT	2.295±0.04c	8704.27±196.01b
CONTROL	2.114±0.06d	8263.00± 293.59c
<hr/>		
<b>Variety</b>		
<hr/>		
KABU	3.216±0.20a	11740.92±671.99a
MUVI●	3.096±0.18ab	9378.75±782.00c
GACE●	2.938±0.17bc	10277.58±489.67b
KASA●	2.859±0.16cd	9095.50±175.74d
MWHT●	2.688±0.17de	9004.58±199.59e
GETU	2.630±0.15e	8154.92±148.95g
ROSE	2.522±0.14ef	8483.83±332.41f
MBRN●	2.387±0.14fg	6918.83±360.07i
KARO●	2.273±0.11gh	7026.08±190.66h
KAYI	2.187±0.12h	6654.25±219.27j

**P value for the main treatments and their interaction**

Rhizobia inoculation	<0.001	<0.001
Bean Variety	<0.001	<0.001
Rhizobial inoculation x Bean Variety	0.006	0.003

KEY: MIX, combination of native and exotic rhizobia; EXT, exotic rhizobia; NTV, native rhizobia; KABU, Kabuu; GACE, Gacere; GETU, Geturu; MUVI, Muviki; MBRN, Mwiternania brown; MWHT, Mwiternania white; KASA, Kasango; KAYI, Kayiero; KARO, Karoyo; ROSE, Rose cocoa; ●, Climber beans

Figures

Figure 1

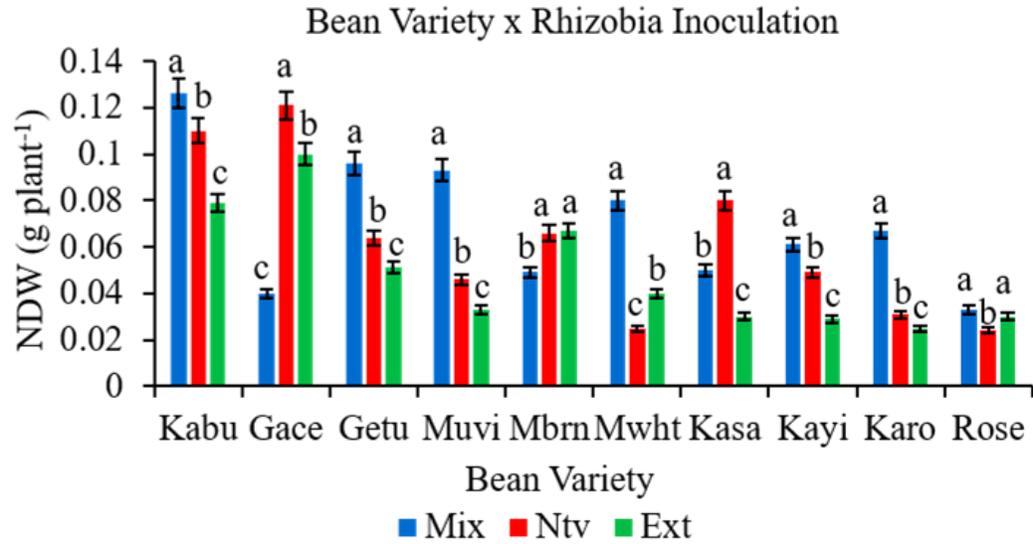


Figure 2

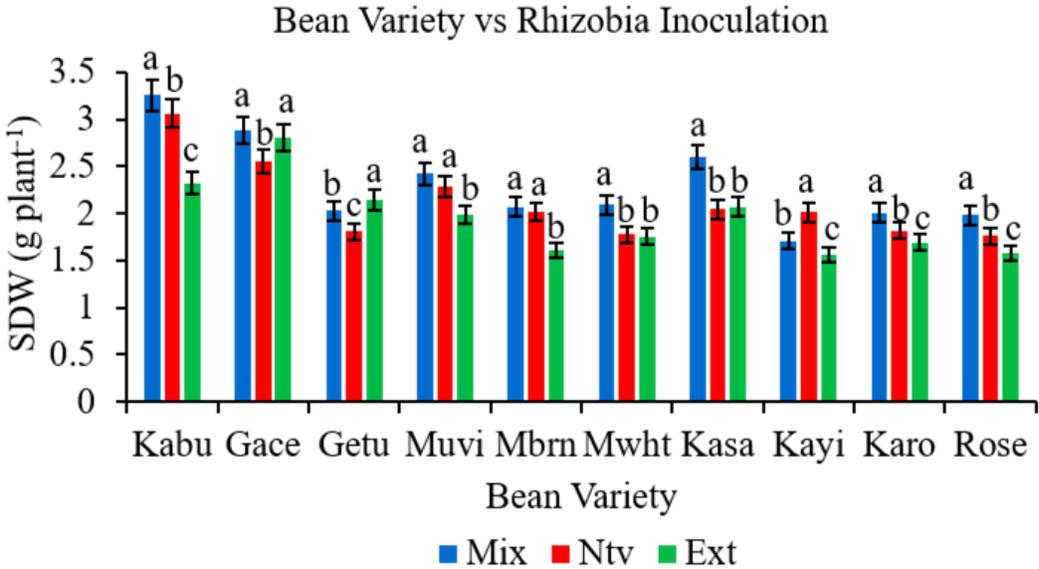


Figure 3

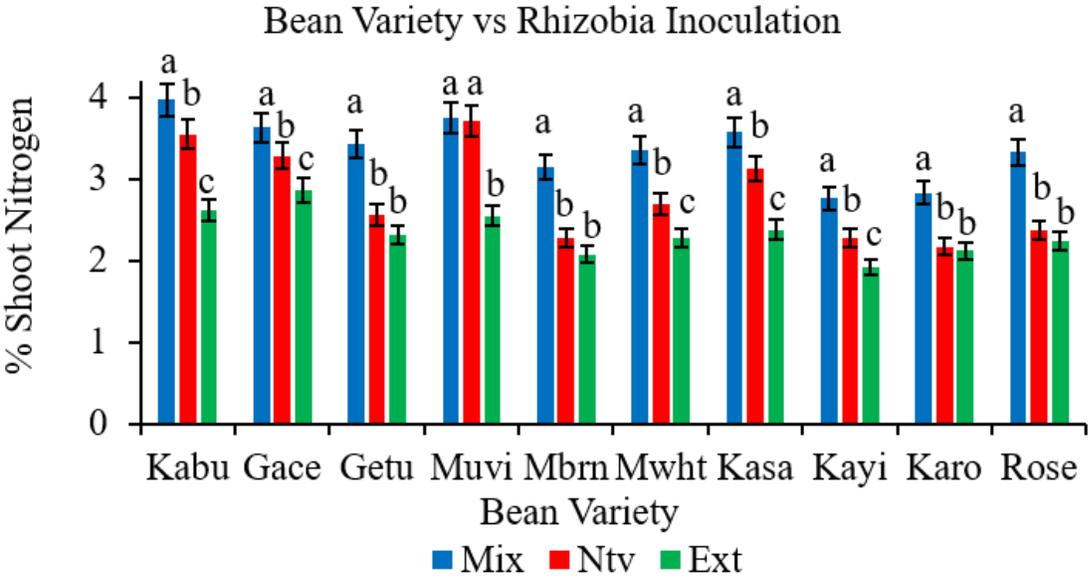


Figure 4

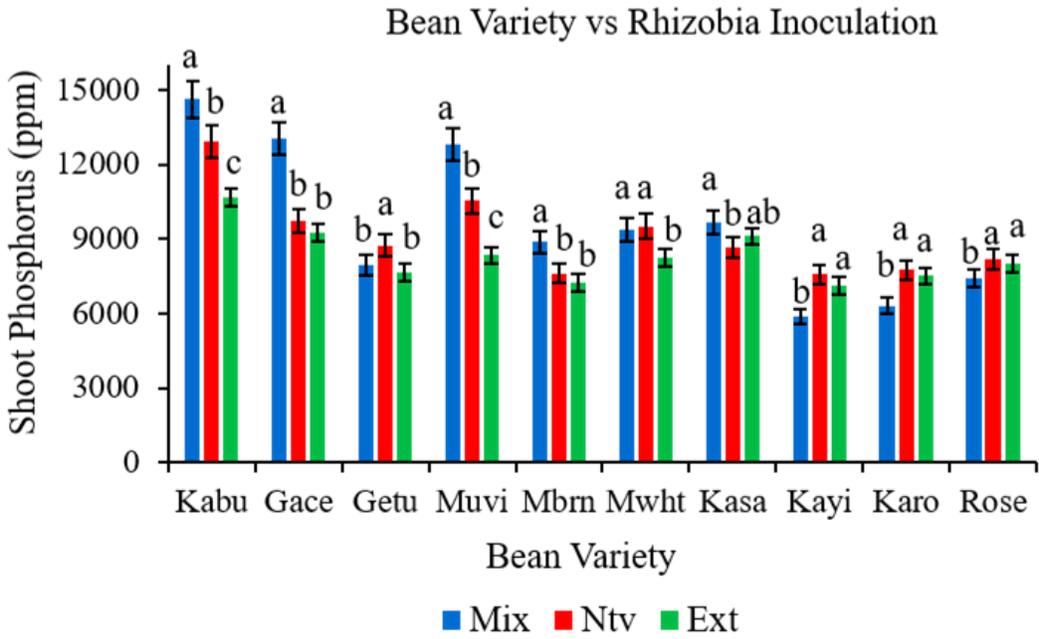
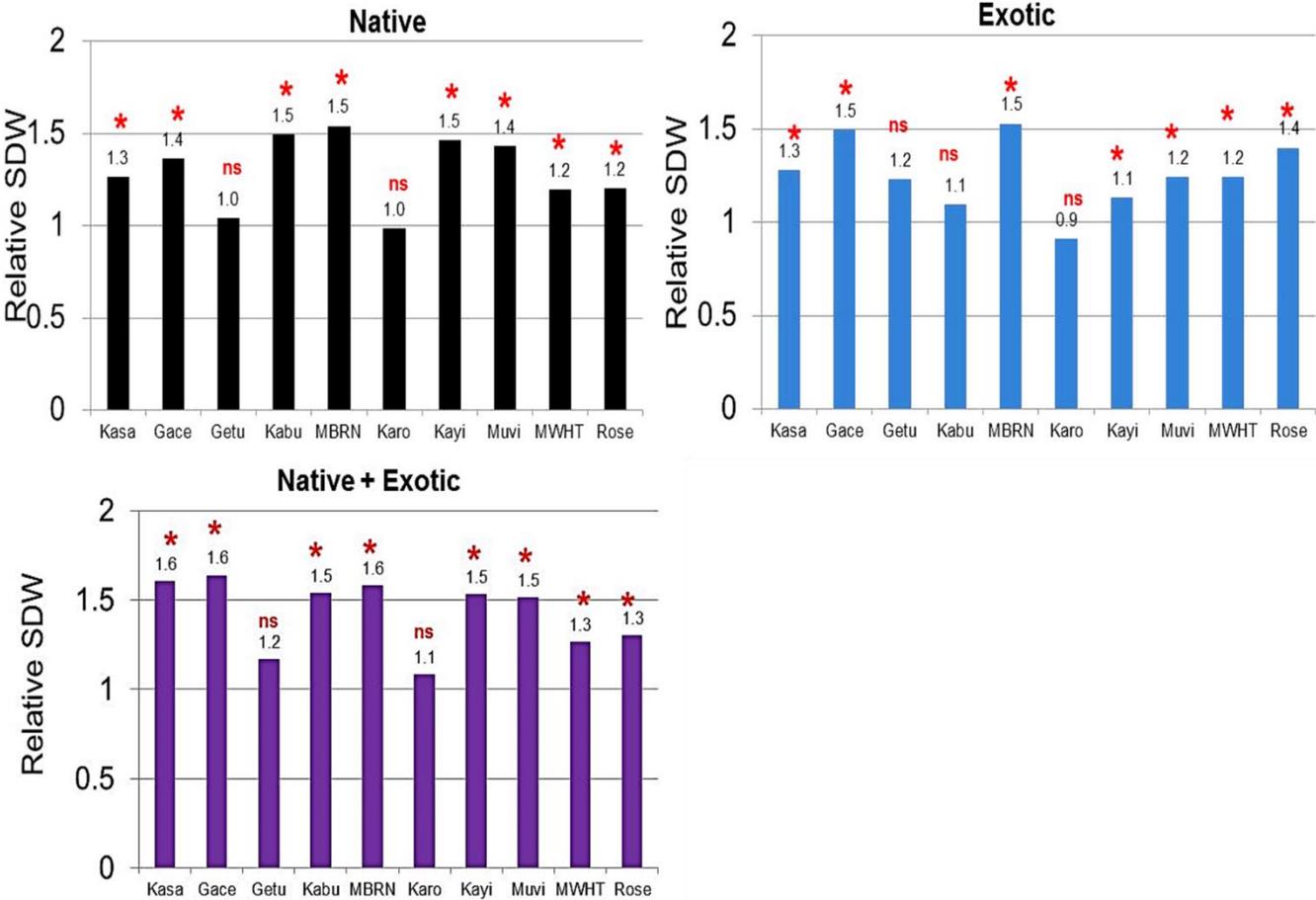


Figure 5



**Figure 6**

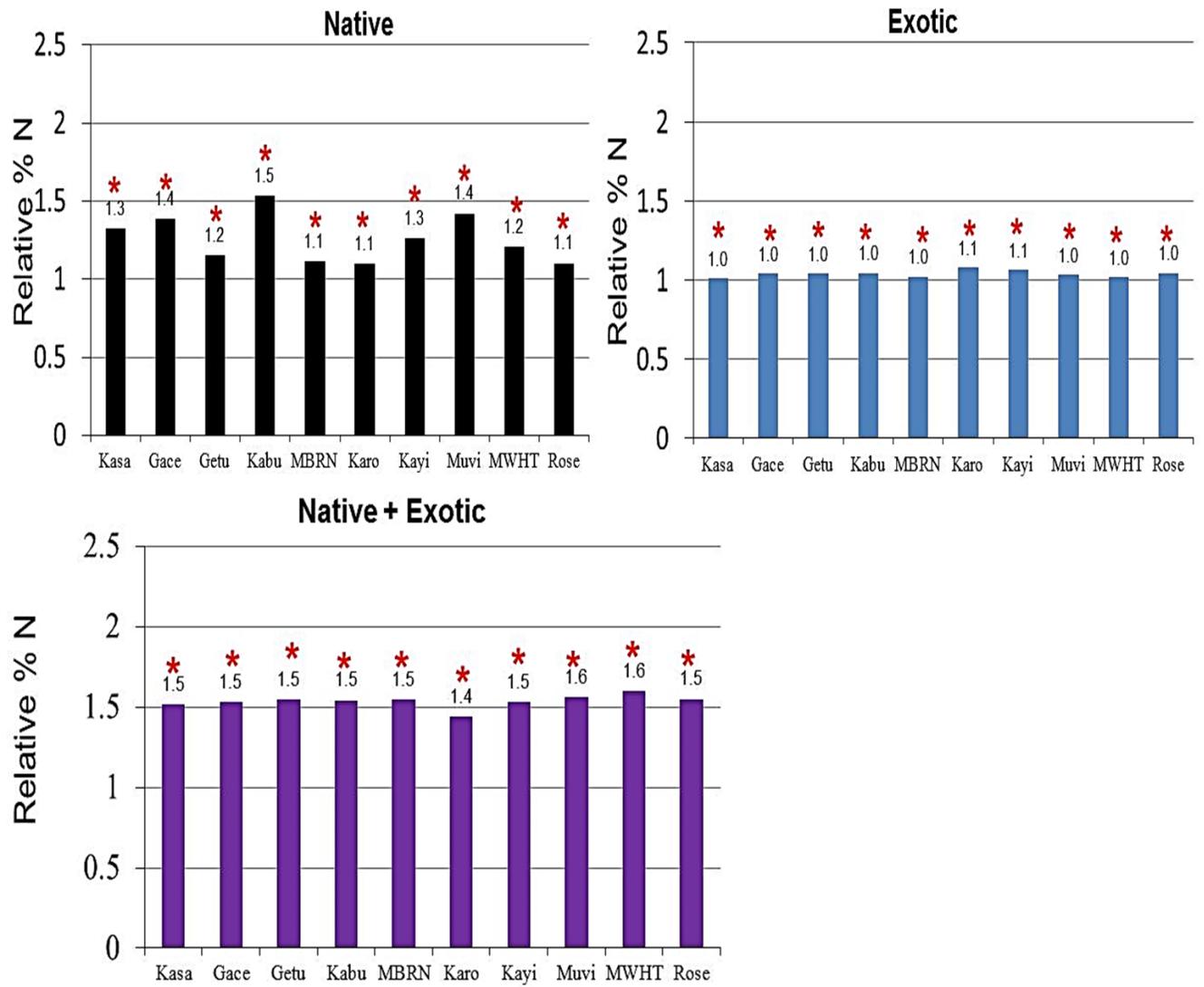
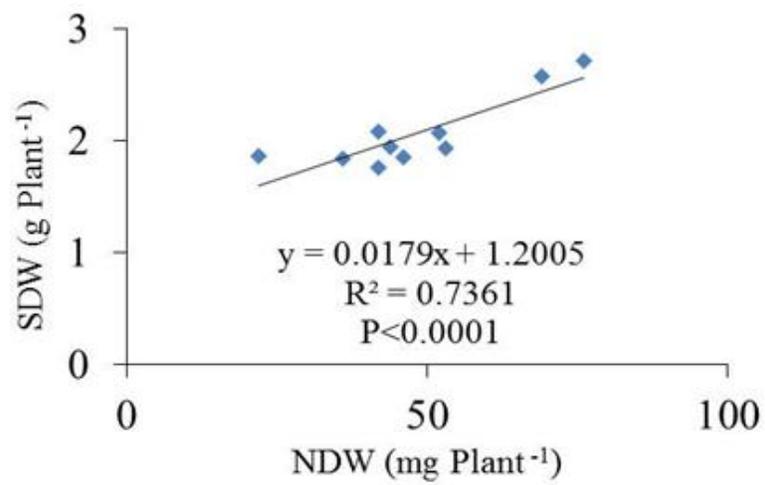
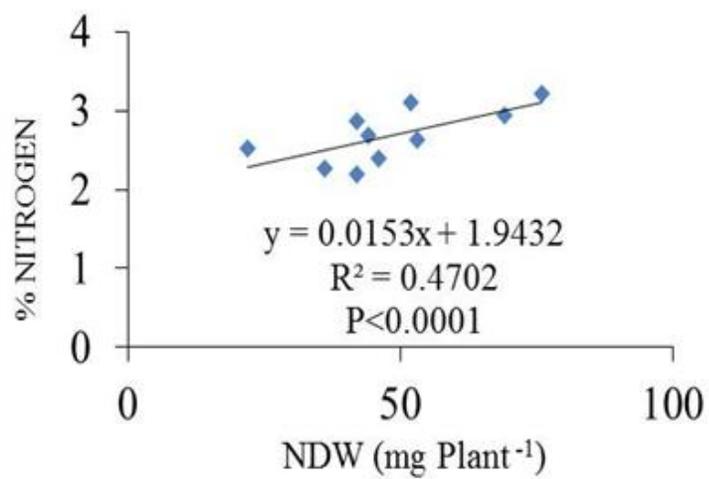


Figure 7



**Figure 8**



# Wastewater Disinfection by Titanium Dioxide (TiO<sub>2</sub>) Solar Photocatalysis

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## **ABSTRACT**

The task of achieving suitable wastewater disinfection without formation of dangerous disinfection by products by chemical disinfectants, as well as increasing need for a versatile wastewater disinfection and reuse systems demands for a new technologies for efficient disinfection and microbial control mechanism. Titanium dioxide (TiO<sub>2</sub>) a metal oxide semiconductor nanomaterial has proved as a powerful antibacterial, antiviral and antifungal properties through diverse mechanism of photo catalytic production of reactive hydroxyl and oxygen species on their surfaces in the presence of solar photons *hν* which inhibits enzyme activity and DNA synthesis ,damages the bacterial cell components and viruses in wastewater that contains these pathogenic agents. This paper reviews the antimicrobial mechanism and disinfection efficiency of Titanium dioxide (TiO<sub>2</sub>) nanoparticle, discusses their merits, limitations and applicability for wastewater disinfection, and highlights research needs by involving more people in order to exploit innovative TiO<sub>2</sub> nanomaterial in wastewater disinfection

## **Introduction**

The world health organization (WHO) requires suitable disinfection of wastewater to protect public health and ecosystem(WWAP, 2014). The development of new technology to achieve suitable disinfection of wastewater without formation of dangerous disinfection by product such as organo chlorine compound formed during chlorination disinfection of water containing organic matter(Veniri, D Mantzavinos, D. , 2012)Nowadays worldwide, access to safe water of about 3.5 billion people are not fulfilled, nearly 2.5 billion people do not have admittance to improved sanitation and around 768 million people do not have admittance to improved source of water (WWAP,2014). According to some estimation, through 2050 more than 40% of global population will live in conditions of severe water stress. The population growth, economic development and urban expansion will increase demand of freshwater in the future, which in turn will affect water-intensive industries. Among the most water-intensive industries, thermal power plants, steel plants and pulp and paper are dominating. For instance, according to different sources pulp and

paper industry can require from 5 to 20 m<sup>3</sup> of water per ton of product (Peter N. Williamson, Hudson, QC,2007) and in some cases up to 1000 m<sup>3</sup> per ton of product, while in sugar industry about 15 m<sup>3</sup> is needed per ton of sugar ( Ranade,V.V and Bhandari, VM, 2014) It is worth making a point that during recent decades environmental impact of pulp and paper industry on water, air and soil was reduced by 80 - 90% [6]. However, environmental policy regarding quality of discharged wastewater is tightening, leading to necessity of new solutions for water treatment not only for pulp and paper industry but for all water-intensive industries as well as industries discharging hazardous wastewater. Water treatment using photocatalysis has gained extensive attention in recent years. Photocatalysis is promising technology from green chemistry point of view. The most widely studied and used photocatalyst for decomposition of pollutants in water under ultraviolet irradiation is TiO<sub>2</sub> because it is not toxic, relatively cheap and highly active in various reactions(Mantzavinos, D. and Veniri, D. 2011)

#### **Other existing water disinfection methods**

The widely known conventional methods of water disinfection are chlorination, ozonisation and ultraviolet (UV) irradiation. Chlorination is the application of chlorine and its related compounds such as elemental chlorine, (chlorine gas), sodium hypochlorite solution or dry hypochlorite . Even though chlorine as disinfectant is cost effective, but cyst forming microorganism survive disinfection using chlorine. Another disadvantages of using chlorine for water disinfection is that, chlorine was found to react with natural organic matter in wastewater to form undesirable chlorinated disinfection by product (DBP) such as trihalomethane and halo acetic acid where many of these products were reported to be carcinogenic(Malatos, *et al* 2009). Furthermore, chlorine in water was reported to be associated with unpleasant taste and odour not only by chlorine its self but also from the odorous by product so formed (Malato*et al*, 2009

#### **Ozonisation**

This is another method of disinfection where ozone (O<sub>3</sub>) is produced or generated on site at a treatment plant by passing dry oxygen through a system at high voltage electrode system. Ozone (O<sub>3</sub>) is reported to be the strongest oxidizing agent with a very strong disinfection ability and was reported to be very effective against pathogenic microbes than chlorination. But, more costly and difficult to monitor and control the process under different conditions(Pillai, S., Seery, M.,

Pelaez, M., 2012)

### **Ultraviolet Water Treatment system(UV Irradiation)**

The ultraviolet germicidal irradiation is a wastewater disinfection method that uses ultraviolet light of short wave length produced from special type of lamp known as germicidal lamp to kill microorganism in wastewater(Zang, Y., Chai, X., and Zeng, J., 2011). Ultraviolet wastewater treatment system has been reported to have a very high effectiveness in removing protozoa, for example *cryptosporidium*, *Giardia*; bacteria for example, *campylobacter*, *salmonella*, *shigella*, *E.coli*; Viruses for example, *Entric*, *Hepatitis A*, *Norovirus* , *Rotavirus*; but reported not effective in removing chemicals from wastewater (Zhang et al, 2012)

### **Titanium dioxide (TiO<sub>2</sub>) solar photo catalytic wastewater disinfection method**

The TiO<sub>2</sub> solar photocatalytic wastewater disinfection method is a new innovation disinfection technology which employs semiconductor titanium dioxide (TiO<sub>2</sub>) as a catalyst and photon energy from the sun in the presence of solar concentrating reactors. This technology relies on photochemically induced damages by chemical species generated on the TiO<sub>2</sub> surface to the pathogenic agent in contact with the catalyst in wastewater (Pillai et al, 2012). The following researchers reported the successful application of solar photocatalytic treatment of engineering scale treatment of industrial non-biodegradable persistent water contaminant (Malato et al, 2009). It has been reported that disinfection by photocatalysis is exceptionally effective due to several mode of action that can be brought to bear on the pathogenic organism which include viruses, bacteria, fungi and algae. Each of these pathogenic agents is associated with challenges in terms of structure and defence mechanism such as cyst formation by microorganism can be effectively by this method( Mantzavinos et al, 2012). Malato et al, 2009 reported the main advantages TiO<sub>2</sub> as a catalyst of choice in photocatalytic water disinfection as it operates under ambient temperature and pressure , but mainly it has the possibility of using solar light as radiation source.

### **Forms of Titanium dioxide (TiO<sub>2</sub>)**

Titanium dioxide chemically written as TiO<sub>2</sub> is also known as titanium(IV) oxide or titania is a naturally occurring oxide of titanium which exist in three different forms as ores. The three different polyforms of TiO<sub>2</sub> are anatase, rutile and brookite. Rutile form is orthorhombic and the most stable form, while anatase and brookite are tetrahedron crystal with a band gap of 3.2 and 3.0 electron volt (eV) respectively (Pillai et al, 2012)

## **Research groups and countries involved in titanium dioxide (TiO<sub>2</sub>) solar photocatalytic wastewater disinfection method**

Research groups who are mostly involved in studying the TiO<sub>2</sub> photocatalytic disinfection process composed mainly of chemists, chemical engineers who are mostly familiar with the terms in photochemistry and reactor issues associated with photocatalytic system. Studies has shown the gradual growth of TiO<sub>2</sub> disinfection research from basic research on laboratory scale to to first trial with real disinfection application( Malato *et al*, 2009; Blake *et al*, 2010; Tsai *et al*, 2010). The countries involved in the research on photocatalytic disinfection method are mostly European countries example Germany, Spain and in Asia, Japan.

## **Fundamentals and mechanism of TiO<sub>2</sub> photocatalysis**

The basics of photo physics and photochemistry underlying the heterogenous photocatalysis employing the semiconductor titanium dioxide TiO<sub>2</sub> catalyst have been extensively reported(Mantzavinos *et al* 212). According to (Jin *et al*, 2010)when photon energy ( $h\nu$ ) which is greater than or equal to band gap energy of the TiO<sub>2</sub> is illuminated on the TiO<sub>2</sub> surface , usually 3.2 for anatase or 3.0 eV for (rutile), the electron will be photo excited to the empty conduction band .

Within this review unmodified and modified TiO<sub>2</sub> materials (powders and thin films) were prepared (Irina, L. 2016). Physico-chemical properties of photocatalytic materials were characterized with UV-visible spectroscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray photoelectron spectrometry (XPS), inductively coupled plasma optical emission spectroscopy (ICP-OES), ellipsometry, time-of-flight secondary ion mass spectrometry (ToF-SIMS), Raman spectroscopy, goniometry, diffuse reflectance measurements, thermogravimetric analysis (TGA) and nitrogen adsorption/desorption. Photocatalytic activity of prepared samples in aqueous environment was tested using model compounds such as phenol, formic acid and metazachlor. Also purification of real pulp and paper wastewater effluent was studied. Concentration of chosen pollutants was measured with high pressure liquid chromatography (HPLC). Mineralization and oxidation of organic contaminants were monitored with total organic carbon (TOC) and chemical oxygen demand (COD) analysis. Titanium dioxide powders prepared via sol-gel method and doped with dysprosium and praseodymium were photocatalytically active for decomposition of metazachlor. The highest degradation rate of metazachlor was observed when Pr-TiO<sub>2</sub> treated at 450°C (8h) was used. The

photocatalytic LED-based treatment of wastewater effluent from plywood mill using commercially available TiO<sub>2</sub> was demonstrated to be promising post-treatment method (72% of COD and 60% of TOC was decreased after 60 min of irradiation). The TiO<sub>2</sub> coatings prepared by atomic layer deposition technique on aluminium foam were photocatalytically active for degradation of formic and phenol, however suppression of activity was observed. Photocatalytic activity of TiO<sub>2</sub>/SiO<sub>2</sub> films doped with gold bipyramid-like nanoparticles was about two times higher than reference, which was not the case when gold nanospheres were used.

## **TREATMENT OF WASTEWATER CONTAINING ORGANIC MATTER**

The total amount of wastewater (sewage, industrial and agricultural) globally discharged to water bodies is tens of millions of cubic meters per day (Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, H. Savelli, 2010) According to some estimation, about 80 – 90 % of all wastewater in developing countries is not treated (World Water Assessment Programme,2009). For instance, an estimated treatment capacity for sewage generated in major cities in India is only about 30 % (R. Kaur, B. Pal,2015) Whereas in EU about 82 % of all generated urban wastewaters have received secondary treatment in 2009-2010 (European Commission,2013. Amount of industrial wastewater varies significantly from country to country. It should be noted that in general almost all water utilized for industrial purposes ends up as wastewater. In developing countries quantities of wastewater generated by the same type of industry are generally higher. For instance, in developed countries steel industry consumes 8 – 10 times lower amount of water per ton of steel than in India. The highest contribution to generation of industrial wastewaters is made by water-intensive industries. The thermal power plants, steel plants and pulp and paper industry were reported to be the most water-intensive industries .

Usually before discharge wastewater is treated by primary clarification followed by biological process Tertiary/advanced treatment is not often applied due to high cost of the processes . Despite applied treatment, wastewater effluent is characterized by high concentration of organic materials, high adsorbable organic halogens (AOX), suspended solids, metal ions, tannins, lignin and derivatives, fatty acids, etc Very often COD value of pulp and paper wastewater effluent exceeds discharging limits and/or recommendations in EU. Thus, according to best available techniques published by the European commission the mean COD value is 103 mg L<sup>-1</sup>[30].

While reported values of COD in pulp and paper effluents varies significantly starting from 592 mg L<sup>-1</sup> up to 9065 mg L<sup>-1</sup> depending on the type of the process(V.K. Saharan, D.V. Pinjari, P.R. Gogate,2014) Hence, additional treatment should be applied in order to reach discharging limits and/or recommendations and minimize and/or prevent negative effect to the environment.

### **Titanium dioxide (TiO<sub>2</sub>) solar photo catalytic wastewater disinfection method**

The TiO<sub>2</sub> solar photocatalytic wastewater disinfection method is a new innovation disinfection technology which employs semiconductor titanium dioxide (TiO<sub>2</sub>) as a catalyst and photon energy from the sun in the presence of solar concentrating reactors. This technology relies on photochemically induced damages by chemical species generated on the TiO<sub>2</sub> surface to the pathogenic agent in contact with the catalyst in wastewater (Pillai et al, 2012).

Heterogeneous photocatalysis is widely studied phenomenon especially in energyrelated issues, purification of water and air, etc. Only in last ten years the number of scientific papers containing word photocatalysis or photocatalyst in the title exceeds 9000( J. Herrmann,1999). And each year number of articles devoted to photocatalysis is increasing (J. Herrmann,1999). It is not surprising because photocatalytic properties of some semiconductors are successfully used worldwide for self-cleaning and antifogging surfaces (J.M. Buriak, P.V. Kamat, K.S. Schanze,2014) cancer therapy, outdoor air purification, deodorization of indoor air, wastewater purification, etc (T.N. Rao, D.A. Tryk, A. Fujishima,2003). Photocatalysis can be defined as a chemical reaction induced by absorption of photons by solid material known as photocatalyst (B. Ohtani,2011). It should be mentioned that photocatalyst does not undergo any chemical changes during and after reaction. In the literature term catalyst is often used instead of photocatalyst. Probably it occurs because some photocatalysts are sometimes used in catalytic reactions as catalysts. But, from thermodynamic point of view the concept of catalysis and photocatalysis is different. Thus, energy-storing reactions can be driven by photocatalysis ( $\Delta G > 0$ ) while catalysis is limited to thermodynamically possible reactions ( $\Delta G < 0$ ) [10]. Absolute or relative reaction rate in the field of photocatalysis is usually referred as photocatalytic activity (B. Ohtani,2011). Photocatalytic process in water can be divided on five steps(J. Herrmann, 1999): Transfer of reactants in water to the surface of photocatalysts Adsorption of reactants on the surface

1. Photonic activation of surface of photocatalyst and reaction in the adsorbed phase
2. Desorption of reaction products
3. Elimination of reaction products from the interface region.

Generally accepted explanation of the main principle of photocatalysis with TiO<sub>2</sub> is often presented as shown in Figure 1

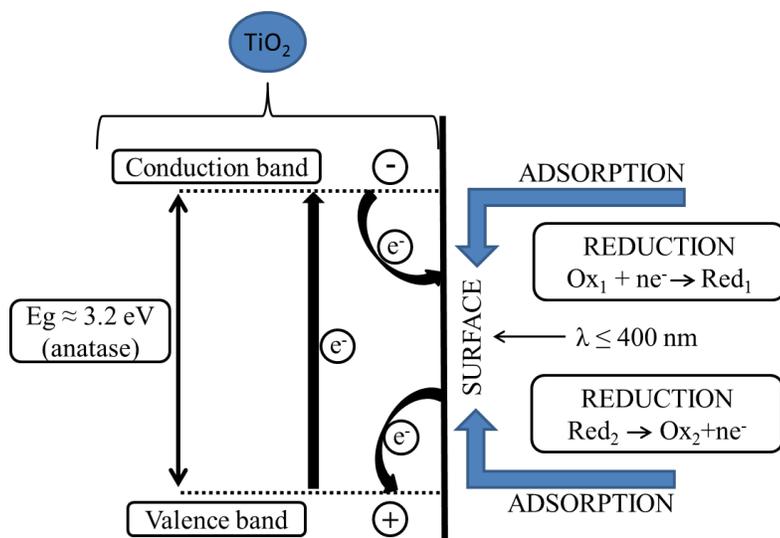


Figure 1: Simplified scheme of TiO<sub>2</sub> photocatalysis (J. Herrmann, 2010)

As shown in Figure 1, when photocatalyst (in present case TiO<sub>2</sub>) absorb the light with energy equal or greater than band gap energy of photocatalyst, formation of electronhole pairs occurs. The last dissociate into positively charged holes ( $h^+$ ) in valence band (VB) and electrons ( $e^-$ ) in conduction band (CB). These charge carriers in the CB and VB reduce and oxidize compounds adsorbed on the surface of photocatalyst, respectively. However, recombination of these charge carriers can occur (Figure 2) causing absence of chemical reaction. Often in the literature decrease or increase of photocatalytic activity is explained by enhanced or suppressed electron-hole recombination, respectively (B. Ohtani,2013). As it was mentioned in recent review (B. Ohtani,2013) no direct confirmation of electron-hole recombination during heterogeneous photocatalysis was reported, which may appear surprising. However, detection of electron-hole recombination is not easy because it proceed with heat liberation.

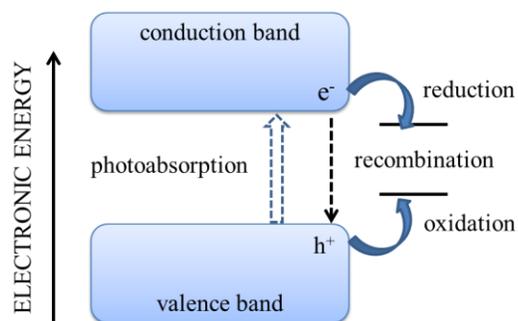


Figure 2: Simplified diagram of electron-hole ( $e^-/h^+$ ) recombination (B. Ohtani,2013)

There are five main physical parameters which are known to influence photocatalytic activity (J. Herrmann,2010). Reaction rate as a function of these parameters is shown in Figure 2.

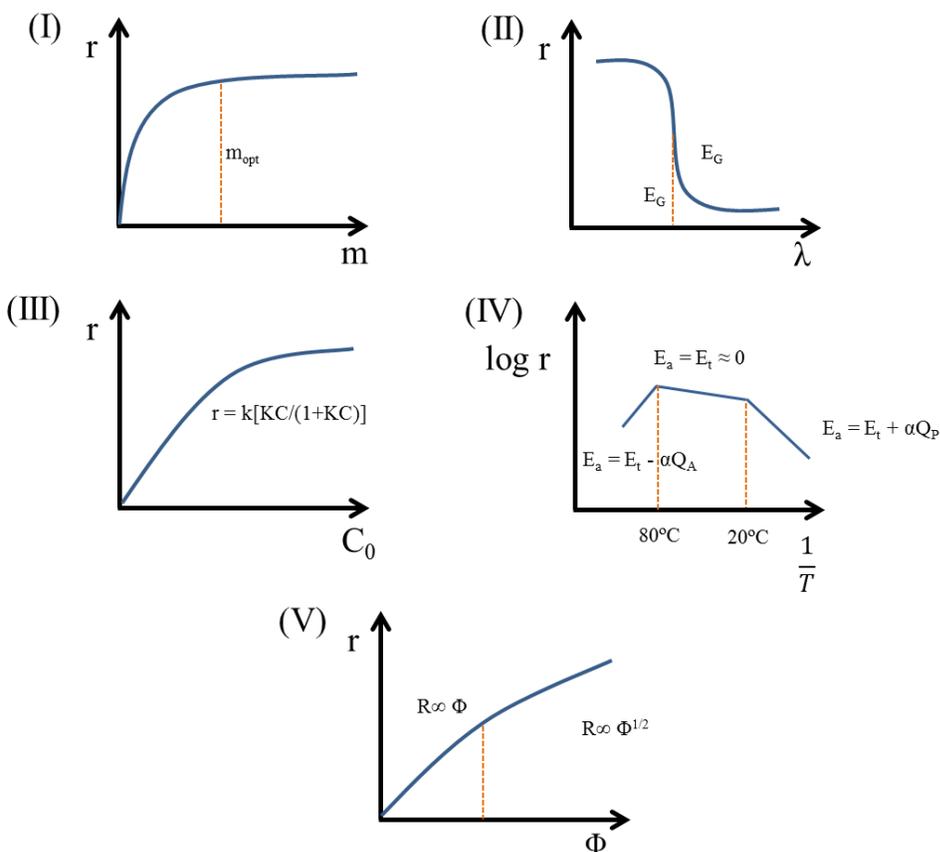


Figure 2: Effect of (I) mass of photocatalyst, (II) wavelength, (III) initial concentration, (IV) temperature and (V) radiant flux on photocatalytic activity (J. Herrmann, 2010)

As it was reported, initial rates of photocatalytic reaction are directly proportional to mass of photocatalyst till certain value after which the function  $r = f(m)$  reach plateau (full absorption of photons). Optimal mass of photocatalyst ( $m_{opt}$ ) depends on operating conditions and reactor geometry (J. Herrmann,2010). Photocatalytic activity strongly depends on the wavelength of the irradiation source (Figure 3.4 II). For instance, for TiO<sub>2</sub> with band energy 3.20 eV the irradiation with  $\lambda \leq 400$  nm is required. Generally kinetics of photocatalytic reactions is described in literature using Langmuir-Hinshelwood mechanism, probably due to its usefulness in modelling process:

$$r = K \frac{KC}{1+KC} \quad \text{equation 1}$$

where  $r$  is true rate constant,  $K$  is the constant of adsorption at equilibrium and  $C$  is the momentary concentration. However, it was demonstrated that rate constants of Langmuir-Hinshelwood mechanism have no physical meaning for photocatalysis (S. Malato, P. Fernández-Ibáñez, M.I. Maldonado, J. Blanco, W. Gernjak,2009).The optimum temperature range for photocatalytic reactions (Figure 2 IV) is between 20°C and 80°C. At very low temperatures photocatalytic activity decreases and desorption of final product becomes rate limiting step. At elevated temperatures (above 80°C) exothermic adsorption of reactant is becoming rate limiting step and activity is decreasing (J. Herrmann,2009). Hence, photocatalytic reactions in aqueous media are attractive since no heating is required. As presented in Figure 2 (V), the photocatalytic activity is proportional to radiant flux ( $\Phi$ ) till certain value. This value significantly varies depending on experimental conditions. For instance, when Philips HPK 125 UV lamp was used critical flux was estimated to be 25 mW/cm<sup>2</sup>. Interestingly, under solar irradiation critical flux is about 2 – 3 mW/cm<sup>2</sup> (S. Malato, P. Fernández-Ibáñez, M.I. Maldonado, J. Blanco, W. Gernjak,2009). After this value reaction rate is proportional to square root of radiant flux ( $\Phi^{1/2}$ ). Thus, the optimal use of irradiation corresponds to area where photocatalytic activity is proportional to radiant flux.

## Advanced materials for photocatalysis

### Desired properties and design of photocatalysts

As it was reported previously (O. Carp, C.L. Huisman, A. Reller, 2004) ideal photocatalyst

should be chemically and biologically inert, stable in photocatalytic reactions, easy to produce and use, cheap, not dangerous for humans and environment and efficient under sun irradiation. Thus, titanium dioxide, the most studied material for photocatalytic applications (J. Schneider, M. Matsuoka, M. Takeuchi, J. Zhang, Y. Horiuchi, M. Anpo, D.W. Bahnemann, 2014) is almost ideal photocatalyst. Moreover, TiO<sub>2</sub> (P25) is used as reference photocatalyst. Many excellent review papers were devoted to titanium dioxide and its photocatalytic properties (R. Fagan, D.E. McCormack, D.D. Dionysiou, S.C. Pillai, 2016). However, photocatalytic activity of TiO<sub>2</sub> and other photocatalytic materials is limited leading to low quantum yields ( $\leq 10\%$ ) (B. Ohtani, 2008). Generally the main limiting factors are (B. Ohtani, 2008)

- recombination of electron-hole ( $e^-/h^+$ ) pairs;
- requirement of ultraviolet light (UV) at a wavelength shorter than ca. 390 nm (X. Lin, J. Xing, W. Wang, Z. Shan, F. Xu, F. Huang, 2007);
- low rates of mass transport between active centers of TiO<sub>2</sub> and organic pollutants.

Numerous attempts to design photocatalytic materials with activity higher than that of TiO<sub>2</sub> were made recently (J.M. Coronado, F. Fresno, M.D. Hernández-Alonso, R. Portela, 2013). Lin et al. suggested that efficient photocatalyst can be designed by combination of n-type semiconductor (with good electron conductivity) with hole-accepting semiconductor with relatively high structure openness degree (J.M. Coronado, F. Fresno, M.D. Hernández-Alonso, R. Portela, 2013). In order to prove this suggestion Bi<sub>2</sub>O<sub>3</sub> (n-type semiconductor) was combined with BaTiO<sub>3</sub> (dielectric and ferroelectric material) and enhanced photocatalytic activity of this material was reported for decomposition of methyl orange and methylene blue. The improvement of photocatalytic activity was associated with electric-field-driven electron-hole separation. Other coupled semiconductors or heterojunctions such as SnO<sub>2</sub>/TiO<sub>2</sub>, TiO<sub>2</sub>/ZrO<sub>2</sub>, CdSe/TiO<sub>2</sub>, BiVO<sub>4</sub>/TiO<sub>2</sub>, BiOCl/BiOI, Bi<sub>2</sub>S<sub>3</sub>/TiO<sub>2</sub> and CdS/TiO<sub>2</sub> (C. Liu, T. Yang, C. Wang, C. Chien, S. Chen, C. Wang, W. Leng, Y. Hwu, H. Lin, Y. Lee, C. Cheng, J.H. Je, G. Margaritondo, 2009) etc. were studied for photocatalytic applications.

Another way to design photocatalytic materials is to use metal nanoparticles with surface plasmon resonance (SPR) as co-catalysts (Y. Yu, P. Zhang, L. Guo, Z. Chen, Q. Wu, Y. Ding, W. Zheng, Y. Cao, 2014). The metal nanoparticles with SPR can absorb light in the semiconductor

and possibly enhance photocatalytic activity. Depending on desired SPR particle size, shape and dielectric environment should be modified. The most used co-catalysts for this purpose is gold and silver nanoparticles because of intense optical absorption and scattering properties. Thus, many scientists reported enhanced photocatalytic activity of TiO<sub>2</sub> modified with Au nanoparticles in UV and/or visible light region (E. Kowalska, R. Abe, B. Ohtani, 2009; ( T. Okuno, G. Kawamura, H. Muto, A. Matsuda, 2014).

An interesting approach for design of advanced photocatalytic materials were reported by Yu et al. (M. Sharma, D. Das, A. Baruah, A. Jain, A.K. Ganguli, 2014). In this work electronic band structures and density of states for TiO<sub>2</sub> nanosheets, nanotubes and nanoparticles were calculated using density functional theory (DFT). After that TiO<sub>2</sub> nanosheets, nanotubes and nanoparticles were synthesized and tested for decomposition of 4-chlorophenol. Experimentally obtained band structures and photocatalytic activities of prepared materials were in agreement with theoretical calculations. Thus, photocatalytic activity ranks in order of nanosheets > nanotubes > nanoparticles.

## **MATERIALS AND METHODS**

### **Photocatalytic materials**

#### **Synthesis**

Sol-gel technique and atomic layer deposition (ALD) were used for preparation of photocatalytic materials. Thin films of TiO<sub>2</sub> were deposited on aluminium foam substrate (thickness 3.2 mm, bulk density 0.2 g cm<sup>-3</sup>, purity 98.5 % and porosity 93%). Before deposition, surface of the substrates was cleaned ultrasonically in water and ethanol and dried at 100°C. Thin films were deposited on 7.5 cm × 2.5 cm substrate. As a precursor TiCl<sub>4</sub> was used, H<sub>2</sub>O was a source of oxygen. The reactor was operated under pressure of about 1 mbar and at temperature 300°C with nitrogen as a carrier and purging gas. Thin film of Al<sub>2</sub>O<sub>3</sub> with thickness about 40 nm was deposited on aluminum foam prior TiO<sub>2</sub> in order to avoid corrosion of substrate. The surface of aluminum foam was uniformly coated allowing maintaining the porosity and gas permeability of the support.

## Experimental setup

### Reactor design

For experiments performed with coatings and powder photocatalysts different types of reactor were used. Powder photocatalysts were tested in batch mode with recirculation (Irina, L. 2016) using tubular glass reactors (borosilicate glass, inner diameter 0.6 cm) attached to the LEDs. The total volume of tubular reactors was 10.7 mL. The volume of model solutions or effluents treated using this reactor design was chosen according to experimental time, required volume and number of samples. An equation (given in fig. below) was used for calculation of contact time.

$$t_{cont} = \frac{(V_r \cdot t)}{V_w} \quad \text{equation2}$$

Where  $t_{cont}$  is contact time (min),  $V_r$  – volume of the reactor (mL),  $t$  – sampling time (min) and  $V_w$  – volume of the water in the system at certain sampling point.

## DISCUSSION

### Photocatalytic activity of TiO<sub>2</sub> powder

Commercial TiO<sub>2</sub> Degussa P25 (without modifications) under UVA irradiation (LEDs) was found to be feasible for posttreatment of pulp and paper wastewater received from local plywood mill (Irina, L. 2016). Formic acid was a model compound for optimization of experimental parameters because it is often found as one of the final intermediates of degradation of more complex organic pollutants. Optimal mass of photocatalyst was defined as 0.5 g L<sup>-1</sup> based on photocatalytic tests performed with formic acid as demonstrated on below in fig 3

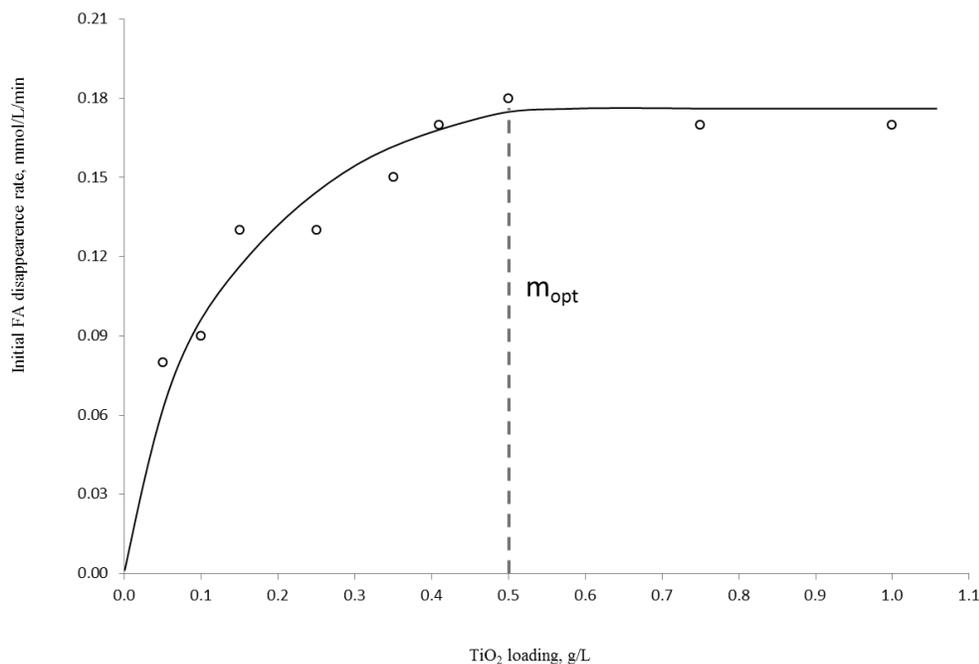


Figure 3: Initial rate of formic acid degradation as a function of mass of TiO<sub>2</sub> (Irinam L, 2016)

Initial rates of formic acid degradation were estimated according to zero order kinetics for 1 min of contact time. From the Figure 5.1 it was concluded that absorption of efficient photons was reached at loading of TiO<sub>2</sub> 0.5 g L<sup>-1</sup>. Optimal mass of TiO<sub>2</sub> obtained in this work is in agreement with other studies conducted with model compounds (R. Wu, C. Chen, C. Lu, P. Hsu, M. Chen

A.2010; Rincón, C. Pulgarin,2004) and real pulp and paper industrial wastewaters (M.Y. Ghaly, T.S. Jamil, I.E. El-Seesy, E.R. Souaya, R.A. Nasr,2011; E.C. Catalkaya, F. Kargi, 2008). Therefore, this optimal mass of photocatalyst was used in further experiments with phenol and plywood mill wastewater. In optimal conditions initial degradation rate of phenol was  $0.033 \text{ mmol L}^{-1} \text{ min}^{-1}$  and it was almost completely eliminated after 6 min under irradiation. Detected by-products of photocatalytic phenol decomposition were hydroquinone, benzoquinone, catechol and formic acid. Formation of hydroquinone, benzoquinone and catechol during phenol decomposition using  $\text{TiO}_2/\text{UV}$  system was reported earlier (A.M. Peiró, J.A. Ayllón, J. Peral, X. Doménech, 2001). According to some studies (A.M. Peiró, J.A. Ayllón, J. Peral, X. Doménech,2001) there are about 20 byproducts generated during photocatalytic decomposition of phenol. Results of TOC measurements confirmed that not all intermediates were determined (Figure 5.2).

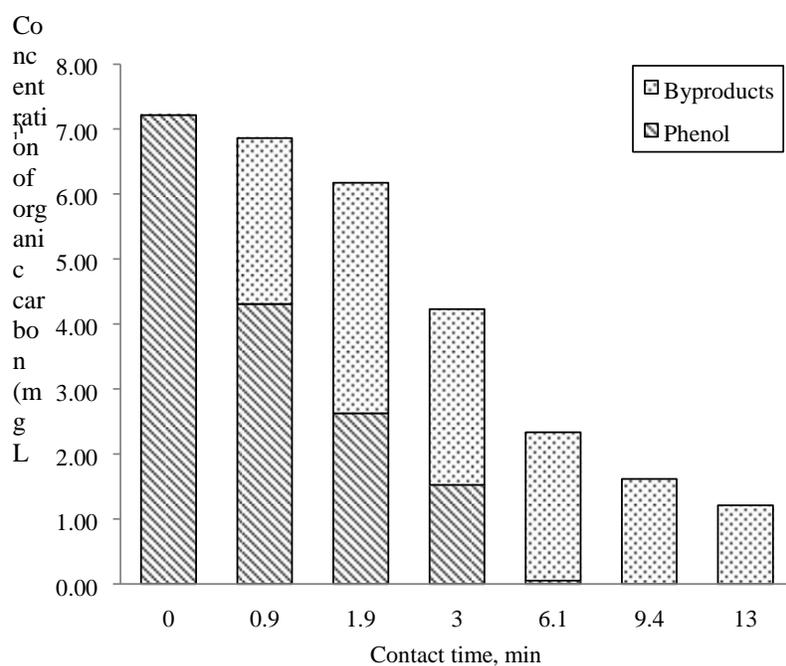


Figure 4: TOC results of photocatalytic phenol degradation

As can be seen from Figure 4, after 6 min of irradiation amount of phenol was about 0.7%, while amounts of benzoquinone, catechol, hydroquinone and formic acid were 20%, 7.9%, 6.2% and 2.9%, respectively. Thus, amount of organic carbon corresponding to detected by-products after 6 min of contact time was equal to 37.7%, which means that rest 62.3% of TOC is unidentified intermediates. After 13 min of contact time mineralization in terms of TOC and COD was 74%

and 69%, respectively. Apparent quantum yields (QY) for phenol and formic acid degradation under optimal conditions were estimated to be 0.98% and 0.8% , respectively. Achieved values of QY are in agreement with reported earlier values of about 1% for majority of photocatalytic reactions in aquatic environment(A. Mills, S. Le Hunte,1997).

The tannic acid present in plywood mill wastewater effluent (initial concentration 0.0088 mM) was fully decomposed after 43 min of contact time. Due to photosensitization properties of humic substances (like tannic acid)( F. Han, V.S.R. Kambala, M. Srinivasan, D. Rajarathnam, R. Naidu,2009), about 45% of this compound was eliminated after 60 min of photolysis. Mineralization of organic pollutants presented in wastewater in terms of TOC and COD is demonstrated on Figure

5.

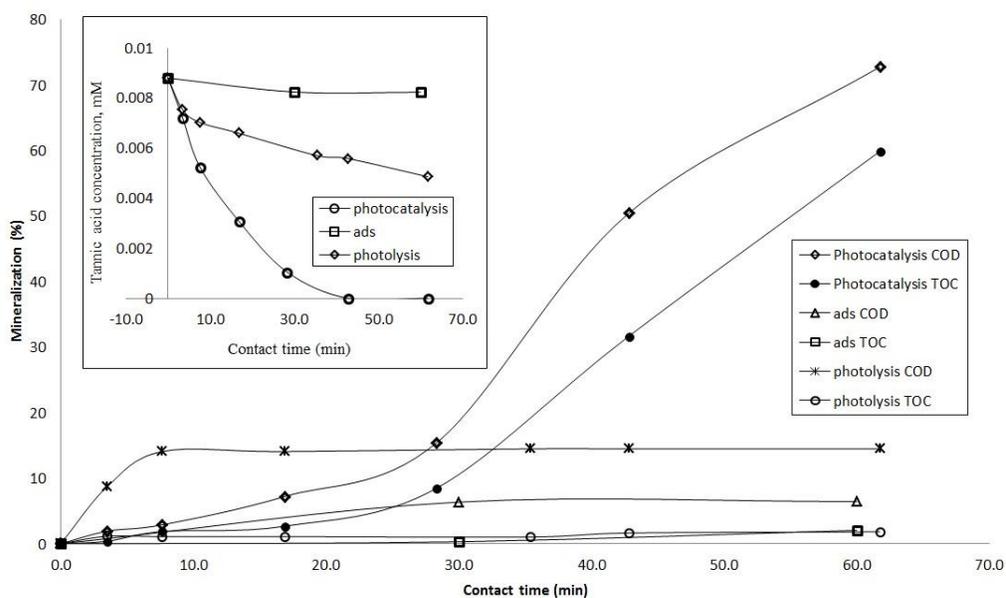


Figure 5: Mineralization of organic pollutants in plywood mill wastewater effluent as a function of contact time. Insert – degradation of tannic acid vs contact time. Source Irina L,2016

As shown in Figure 5, Irina L, reported that after 60 min of photocatalytic wastewater treatment TOC and COD removal reach values 60% and 72%, respectively. During first 30 min of contact

time average TOC removal per power unit of LEDs emission was about 0.14 mg TOC/W. With the increase of contact time this value increased up to 1 mg TOC/W and then declined. Calculated average oxidation state of carbon atoms (AOSC) confirmed oxidation of organic compounds in wastewater leading to changes in AOSC value from -0.8 in the beginning of photocatalytic test to +0.7 in the end. Thus, UVA-LED based photocatalytic treatment can be considered as promising technique for advanced treatment of post-treatment of industrial pulp and paper wastewater effluents.

## **Conclusion**

Photocatalysis is an efficient method which can address environmental issues such as purification of water and air. The field of photocatalysis is constantly developing. Scientists are preparing new photocatalytic materials in order to improve photocatalytic activity of titanium dioxide known as benchmark material. In spite of this fact, titanium dioxide is one of the most studied photocatalysts nowadays. This work was devoted to review on disinfection researches conducted by group of researchers from Matsunga et al,(1985) to date on TiO<sub>2</sub> and modified TiO<sub>2</sub> materials for photocatalytic water treatment. Materials were prepared in the form of powders and thin films. Feasibility of UVA-LED based photocatalytic treatment of plywood mill wastewater effluent was demonstrated by Irina L, (2016)Commercially available TiO<sub>2</sub> (Degussa P25) was used as a photocatalyst. Results suggest that photocatalysis can be successfully applied as post-treatment method for industrial effluents (pulp and paper, refinery, textile, etc.) containing organic compounds some of which can be recalcitrant. What has been observed in all TIO<sub>2</sub> disinfection research are all related to reactive oxygen species such as those normally associated with irradiated TIO<sub>2</sub>. Based on the information obtained from the result by recently conducted research, we can only conclude that disinfection conditions are highly dependant on reactor configuration, light source, type of of TIO<sub>2</sub> and organism as reported by various researchers.

## **Recommendations**

It is important for researchers on TiO<sub>2</sub> solar catalytic disinfection of wastewater to continue to strive for clearly defined condition for experiments so that comparison can be made between targeted organism. The effectiveness of some light sources used for irradiating TiO<sub>2</sub> that are not rated to have output within the band gap of anatase or rutile phase of the TiO<sub>2</sub> suggests that cell killing might be effective at very low dose of ultra violet (UV) light. Therefore, far it appears that the more we move away from controlled laboratory media, the more challenging it become to destroy pathogenic agent because pathogenic agents equip themselves in the wild with with defenses which are difficult to overcome. There are multiple mode of destructive action which are characteristic to solar TiO<sub>2</sub> photocatalytic disinfection method that can operate simultaneously, such as absorption/trapping, reactive oxygen species and direct and indirect photochemistry.

Finally, for TiO<sub>2</sub> solar photocatalytic disinfection process to lead to industrial or large scale application according to (Chong, M.N., Jin, B., and Saint, C., 2010) who reported that recent TiO<sub>2</sub> disinfection research that focuses more on disinfection applied to more resistant microorganism. It is critical to develop the process up a level where the process is robust that is minor to moderate changes to water stream which does not strongly affects the plant efficiency, is cheap compared to other disinfection methods, sustainable, easy to implement, easy to maintain and operate such as in the less developed countries of the world especially in Africa, low risk regarding health and safety for staff handling TiO<sub>2</sub>, safe regarding environment

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## Heat and Mass Transfer Past a Semi- Infinite Vertical Porous Plate in MHD Flows in Turbulent boundary layer

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### ABSTRACT

This study addresses the problem of unsteady free convection incompressible MHD fluid flow past a semi-infinite vertical porous plate in the presence of a strong magnetic field inclined at an angle  $\theta$  to the plate with Hall and Ion-Slip currents. It investigates the effects of Grashof number, heat source parameter, suction velocity, time, angle of inclination, Ion-Slip, Hall current and mass diffusion parameter on the convectively cooled or convectively heated plate restricted to turbulent boundary layer of the flow field. The partial differential equations governing the flow problem considered in our study are solved by a finite difference approximation while the computation of skin friction, rate of heat transfer and mass transfer at the plate is achieved by Newton's interpolation approximation over the first five points. The results show that the Hall current, Schmidt number, Modified Grashof number, heat source parameter, suction velocity, time, angle of inclination, Ion-Slip current on the convectively cooled or convectively heated plate affect the velocity, temperature and concentration profiles. Increases in Hall parameter cause a decrease in both primary and secondary profiles while increase in Ion Slip current parameter leads to increase in primary velocity profiles but a decrease in secondary velocity profiles. Consequently, their effects alter the skin friction, rate of mass transfer and the rate of heat transfer.

**Keywords:** Heat transfer, Mass transfer, MHD, Turbulent flow, Semi-infinite plate, Hall and Ion-Slip currents

### INTRODUCTION

#### Convection heat transfer

Convection heat transfer involves the energy exchange between a boundary surface and the adjacent fluid due to temperature variations. It's not possible to separate the problem of heat transfer from that of the motion of the fluid, and so a study of the hydrodynamic behaviour of the fluid is very much necessary in order to gain an understanding of the heat transfer phenomena within a moving fluid. Analysis of this behaviour requires the application of the principles of conservation of mass (continuity equation), Newton's laws of motion (momentum equations), and

the laws of thermodynamics (energy equation) along with the phenomenological laws like Fourier's laws, Fick's laws and Newton's law of viscosity.

Fluids include both liquids and gases. While liquids are incompressible, gases are compressible, having their densities varying with pressure greatly, and also with temperature.

The study of heat transfer by convection is concerned with the calculation of rates of heat exchange between fluids and solid boundaries. Transfer of fluids between solids and fluid involves the mass, momentum and heat transfer. Modes of heat transfer are by conduction, convection and radiation.

### **Mass transfer**

The bulk flow of fluid due to pressure gradient occurring at a macroscopic level is a kind of mass transfer usually treated in the subject of fluid mechanics. In this work our concern is mass transfer occurring at a microscopic or molecular level, which deals with the transport of one constituent of a fluid solution or gas mixture from a region of higher concentration to a region of lower concentration. Heat is transferred in a direction which reduces an existing temperature gradient, and mass is transferred in a direction which reduces an existing concentration gradient. Drying, evaporation, chemical reaction, absorption, adsorption, solution and so on are all instances of mass transfer.

### **Magnetohydrodynamics (MHD)**

MHD studies the motion of electrically conducting fluid in the presence of a magnetic field. This motion leads to induced electric currents on which mechanical forces are exerted by magnetic field. The induced electric currents in turn produce induced magnetic field which affect the original magnetic field.

### **Hall and Ion-Slip Currents**

The electrical current density  $\vec{J}$  represents the relative motion of charged particles in a fluid. The equation of electric current density may be derived from the diffusion velocities of the charged particles. The major forces on charged particles are electromagnetic forces. If we consider only the electromagnetic forces, we may obtain the generalized Ohm's law. However, the deduction from the diffusion velocity of charged particles is more complicated than the generalized Ohm's law. When electric field  $\vec{E}$  is applied, there will be an electric current in the

direction of  $\vec{E}$ . If the magnetic field  $\vec{H}$  is perpendicular to  $\vec{E}$ , there will be an electromagnetic force  $\vec{J} \times \vec{B}$ , which is perpendicular to both  $\vec{E}$  and  $\vec{H}$ , which is known as Hall current. For the same electromagnetic force, the motion of ions is different from that of electrons, when the electromagnetic force is very large (such as in a very strong magnetic field) the diffusion velocity of ions cannot be neglected. If we consider the diffusion velocity of ions as well as that of electrons, we have the phenomenon of Ion-slip current.

In turbulent flow, the transport mechanism is aided by innumerable eddies. Irregular velocity fluctuations are superimposed upon the motion of the main stream, and these fluctuations are primarily responsible for the transfer of heat as well as momentum.

The fluid motion may be caused by external mechanical means for example by a fan, pumps, in which case the process is called forced convection. If the fluid motion is caused by density differences which are created by the temperature differences existing in the fluid mass, the process is called free convection or natural convection. In natural convection, flow velocities are produced by the buoyancy forces only; hence there are no externally induced flow velocities. As a result, the Nusselt number doesn't depend on Reynolds number.

Buoyant force causes denser parts of the fluid to move downwards and less dense parts to move upwards. The density differences can result from various effects such as differences in concentration of dissolved matter or in temperature.

Typical examples of turbulent flows are flow around, as well as in cars, Aeroplanes and buildings.

Yamamoto and Tomoaki (2011) discussed heat transfer degradation in high Prandtl number fluid which was evaluated via direct numerical simulation (DNS). Target flow fields were fully developed turbulent channel flows imposed a wall-normal magnetic field in the high and low Prandtl number conditions ( $Pr = 5.25$  and  $0.025$ , respectively). Values of the bulk Reynolds number ( $Re_b = 14,000$ ) and the Hartmann number

( $Ha = 0-32$ ) were set to be equivalent to those of the previous experimental study by Yokomine et al. The numerical results of the Nusselt number for the high Prandtl number fluid were in good agreement with the experimental results.

Xenos M. et al. (2009), researched on methods of optimizing separation of compressible

turbulent boundary-layer flow over a wedge with heat and mass transfer, the steady, compressible, turbulent boundary-layer flow, with heat and mass transfer, over a wedge, is numerically studied. The obtained results show that the flow field can be controlled by the suction/injection velocity and it is influenced by the dimensionless pressure parameter  $m$ .

Shin-ichi et al (2010) studied direct numerical simulation of unstable stratified turbulent flow under a magnetic field, in this research; liquid-metals as coolant material in a fusion reactor have a significant role in the design of advanced reactors. Using the simulation, they observed that with an increase in heat transfer, thermal plume by the effect of buoyancy filled the entire region of the channel. In case of an applied magnetic field, it was seen that the turbulence became weak with the magnetic field, although the thermal transport was also increased by the buoyancy effect of the thermal plume.

Mathew Kinyanjui et al. (2012) investigated a turbulent flow of a rotating system past a semi-infinite vertical porous plate. They considered the flow in the presence of a variable magnetic field. They noted that the Hall current, rotation, Eckert number, injection and Schmidt number affect the velocity, temperature and concentration profiles.

Bo Lu et al. (2013) did a study on three dimensional MHD simulation of the electromagnetic flow meter for laminar and turbulent flows, their Numerical results show that induced electric potential difference at the electrodes agreed with the theoretical values. Simulations also render the detailed distributions of induced electric field, current density, electric potential and induced magnetic field. Buffetta G. et al. (2012) in their paper, the ultimate state of thermal convection in Reyleigh-Taylor turbulence, discusses the so-called ultimate state of thermal convection, first proposed by Kraichnan almost 50 years ago and recently observed in numerical simulations of turbulent convection in the absence of boundaries. They focus on numerical simulations of turbulence generated by the Rayleigh–Taylor instability in a wide range of Rayleigh and Prandtl numbers and results point out to the conclusion that RT turbulence provides a natural realization of the ultimate state of thermal convection thus highlighting the relationship between the absence of boundaries and the emergence of the ultimate state scaling for global statistical quantities.

Sanvincente E et al. (2013) had an experimental study on natural convection flows in a differentially heated open channel configuration. The applications concern the free cooling of

both the photovoltaic components integrated within the building envelope (double-skin configuration) and the building itself. Particular focus is given to the identification of integration configurations favorable to both heat transfer on the rear side of components and buoyancy enhancement. The test section consists of a vertical channel with two walls composed of different heating modules. In the present investigation the thermal configuration considers one wall heated uniformly while the other is not heated. They focus on the kinematic characteristics of the flow and convective heat transfer at the heated wall. The experimental evidence shows that the flow is neither really turbulent nor purely laminar for the range of Rayleigh numbers considered. Although the average characteristics of the flow seem perfectly consistent with the results obtained, changes of behavior seem to occur intermittently.

Mohammad Zoynal Abedin et al. (2012) carried out study on turbulence characteristics and vertical structures in combined convection boundary layers along a heated vertical flat plate, They performed Time-developing direct numerical simulations for the combined-convection boundary layers created by imposing aiding and opposing free streams to the pure natural-convection boundary layer in air along a heated vertical flat plate to clarify their structural characteristics. The numerical results reveal that with a slight increase in free stream velocity, the transition region moves downstream for aiding flow and upstream for opposing flow. Mathew Kinyanjui et al. (2012) investigated a turbulent flow of a rotating system past a semi-infinite vertical porous plate. They considered the flow in the presence of a variable magnetic field. They noted that the Hall current, rotation, Eckert number, injection and Schmidt number affect the velocity, temperature and concentration profiles.

Yasuo Hattori et al. (2006) did investigate on the turbulence characteristics of a natural-convection boundary layer in air along a vertical plate heated at high temperatures experimentally. In their study two-dimensional velocity vectors and instantaneous temperature in the boundary layer at a wall temperature up to 300 °C are measured using a particle image velocimetry and a cold wire found that heat transfer rates even for a wall temperature of 300 °C are well expressed by an empirical formula obtained for low wall temperature and the region of transition from laminar to turbulence does not change much with an increase in wall temperature. In addition, the profiles of turbulent quantities measured at a wall temperature of 300 °C resemble those observed at low wall temperatures, and thus the effects of high heat on the

turbulent behavior in the boundary layer are quite small. The measured velocity vectors and the higher-order statistics, such as skewness and flatness factors of fluctuating velocities and temperature, also suggest that the structure of large-scale fluid motions in the outer layer of the natural-convection boundary layer, closely connected with turbulence generation, is maintained even under high wall temperature conditions.

### Specific equations governing fluid flow

The equations governing incompressible unsteady free convection fluid flow in the presence of heat and mass transfers are considered. In this study unsteady free convection magnetohydrodynamic flow past a semi- infinite vertical porous plate subjected to a strong magnetic field inclined at an angle of  $\theta$  to the plate and constant suction is studied. The  $x^*$  - axis is taken along the plate in vertically upward direction, which is the direction of flow.

The  $z^*$  - axis taken normal to the plate, since the plate is semi- infinite in length and for a two-dimensional free convective fluid flow the physical variables are functions of  $x^*, z^*$  and  $t^*$ . The

fluid is permeated by a strong magnetic field  $\vec{H} = (H_0\sqrt{1-\psi^2}, 0, H_0\psi)$  where  $H_0 = |H|$  is the magnitude of the magnetic field and  $\psi = \cos\theta$ .

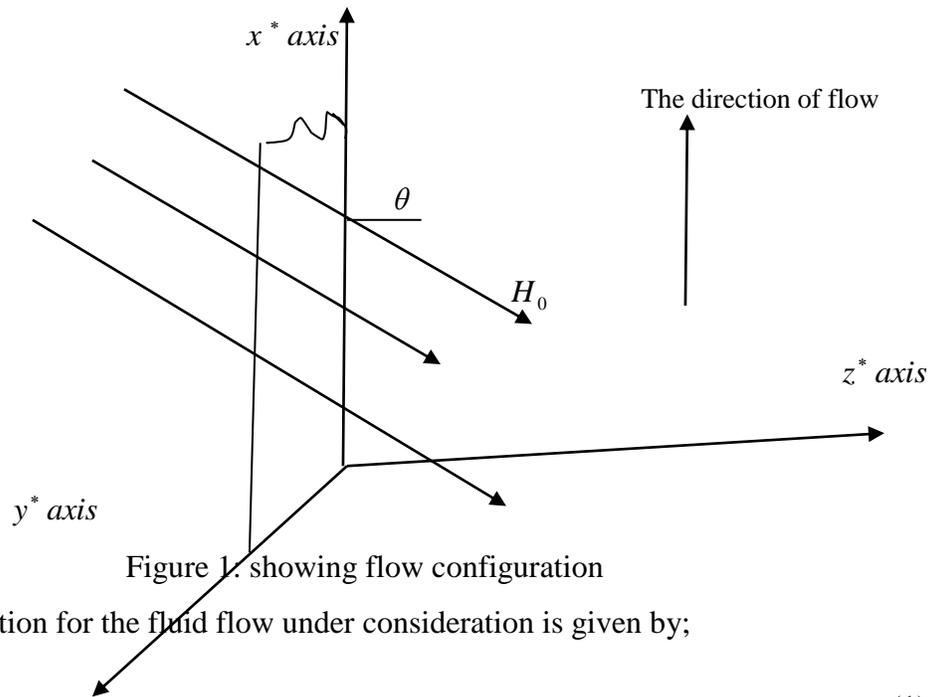


Figure 1. showing flow configuration

The continuity equation for the fluid flow under consideration is given by;

$$\frac{\partial w^*}{\partial z^*} = 0 \tag{1}$$

Since the fluids particle velocity equal to zero because of no-slip condition. On integration equation (3.4.9) gives the constant suction velocity

$$w^* = -w_0^* \quad (2)$$

To determine the pressure gradient term in momentum equation

$$\rho \left( \frac{\partial U_j}{\partial t} + U_j \frac{\partial U_i}{\partial x_j} \right) = -\frac{\partial p}{\partial x_j} + \rho \nu \nabla^2 U_i + \rho g + J \times B \quad \text{the momentum equation is}$$

evaluated at the edge of the boundary layer where  $\rho \rightarrow \rho_\infty$  and  $U \rightarrow 0$ . The pressure term in the

$x^*$  direction,  $-\frac{\partial p}{\partial x^*} = -\rho_\infty g$  results from the change in the elevation. The body force term in

eqn. 2.7 along negative  $x^*$  direction is  $-\rho g$ . Combining the pressure term and the body force term gives.

$$-\rho g - \frac{\partial p}{\partial x^*} = g(\rho_\infty - \rho) \quad (3)$$

If the volumetric coefficient of thermal expansion is defined by

$$\beta = -\frac{1}{\rho} \left( \frac{\Delta \rho}{\Delta T} \right)_p = -\frac{1}{\rho} \left( \frac{\rho_\infty^* - \rho^*}{T_\infty^* - T^*} \right) = \frac{1}{\rho} \left( \frac{\rho_\infty^* - \rho^*}{T^* - T_\infty^*} \right) \quad (4)$$

and the volumetric coefficient of thermal expansion with concentration of the fluid by

$$\beta' = -\frac{1}{\rho} \left( \frac{\Delta \rho}{\Delta C} \right)_p = -\frac{1}{\rho} \left( \frac{\rho_\infty^* - \rho^*}{C_\infty^* - C^*} \right) = \frac{1}{\rho} \left( \frac{\rho_\infty^* - \rho^*}{C^* - C_\infty^*} \right) \quad (5)$$

From equation (1) and equation (2) we have,

$$\begin{aligned} \beta \rho (T^* - T_\infty^*) &= p_\infty^* - p^* \\ \beta' \rho (C^* - C_\infty^*) &= p_\infty^* - p^* \end{aligned} \quad (6)$$

The total change in density as a result of temperature and concentration is given by

$$\Delta \rho = \beta \rho (T^* - T_\infty^*) + \beta' \rho (C^* - C_\infty^*) \quad (7)$$

From Ohm's law  $J = \sigma(q \times B)$ , where  $J$  is the electric current density  $J = (J_{x^*}, J_{y^*}, J_{z^*})$  and  $B$  is

the magnetic induction,  $B = (\mu_e H)$  which in component form is given as,

$$B_{x^*} = \mu_e H_0 \sin \theta$$

$$B_{y^*} = 0$$

$$B_{z^*} = \mu_e H_0 \cos \theta$$

$$J = \sigma \begin{vmatrix} i & j & k \\ u^* & v^* & 0 \\ B_{x^*} & 0 & B_{z^*} \end{vmatrix} = \sigma(v^* B_{z^*} i - u^* B_{z^*} j) = \sigma \mu_e H_0 \psi (v^* i - u^* j) \quad (8)$$

Where the term in equation (2.7) can be simplified as,

$$J \times B = \begin{vmatrix} i & j & k \\ J_{x^*} & J_{y^*} & 0 \\ \mu_e H_0 \sqrt{1-\psi^2} & 0 & \mu_e H_0 \psi \end{vmatrix} = i J_{y^*} \mu_e H_0 \psi - j J_{x^*} \mu_e H_0 \quad (9)$$

From the equation of conservation of electric charges  $\nabla \cdot J = 0$ , gives  $J_{z^*} = \text{constant}$ , this constant is zero, since  $J_{z^*} = 0$  at the plate which is electrically non-conducting hence  $J_{z^*} = 0$  everywhere in the flow,  $B_{y^*} = 0$  due to the geometrical nature of our problem.

Substituting equations (3.5.5) and (3.5.7) in equation (3.4.2) and writing the result in component form to obtain;

$$\rho \left( \frac{\partial u^*}{\partial t^*} + u^* \frac{\partial u^*}{\partial x^*} - w_0^* \frac{\partial u^*}{\partial z^*} \right) = \mu \left( \frac{\partial^2 u^*}{\partial x^{*2}} + \frac{\partial^2 u^*}{\partial z^{*2}} \right) + \beta \rho (T^* - T_\infty^*) + \beta' \rho (C^* - C_\infty^*) + \mu_e \psi H_0 J_{x^*} \quad (10)$$

$$\rho \left( \frac{\partial v^*}{\partial t^*} + u^* \frac{\partial v^*}{\partial x^*} - w_0^* \frac{\partial v^*}{\partial z^*} \right) = \mu \left( \frac{\partial^2 v^*}{\partial x^{*2}} + \frac{\partial^2 v^*}{\partial z^{*2}} \right) - \mu_e \psi H_0 J_{y^*} \quad (11)$$

The generalized ohm's law including the effect of Hall current is written as;

$$j + \frac{we \tau e}{H} (j \times H) = \delta \left[ E + \mu_e (q \times H) + \frac{1}{e \eta_e} \nabla p_e \right] \quad (12)$$

For the partially ionized fluids the electron pressure gradient may be neglected.

In this case we consider a short circuit problem in which the applied electronic field =0. Thus neglecting electron pressure the x and y components become;

$$j + \frac{we \tau e}{H} (j \times H) = \delta \mu_e (q \times H) \quad (13)$$

Expanding the equation we get

$$(J_y, J_z) + \frac{we \tau e}{H} (j_z H_0, -j_y H_0) = \delta \mu_e (v H_0 - w_0 H_0) \quad (14)$$

Solving these equations for current density components  $j_y$  and  $j_z$

$$J_y = \frac{\delta\mu_e H_0 (mv - w)}{1 + m^2} \quad (15)$$

$$J_z = -\frac{\delta\mu_e H_0 (v - mw)}{1 + m^2} \quad (16)$$

Where  $m = we\tau$  is the hall parameter.

Substituting equations (3.48) and (3.49) in the momentum equations and introducing the shear stress terms  $\frac{\partial uv}{\partial x}$  and  $\frac{\partial uw}{\partial x}$  yields

$$\begin{aligned} \rho \left( \frac{\partial u^*}{\partial t^*} + u^* \frac{\partial u^*}{\partial x^*} - w_0^* \frac{\partial u^*}{\partial z^*} \right) &= \mu \left( \frac{\partial^2 u^*}{\partial x^{*2}} + \frac{\partial^2 u^*}{\partial z^{*2}} \right) + \beta \rho (T^* - T_\infty^*) \\ &+ \beta' \rho (C^* - C_\infty^*) - \frac{\partial uv}{\partial x} + \frac{\delta\psi\mu_e^2 H_0^2 (mv - w)}{1 + m^2} \end{aligned} \quad (17)$$

$$\rho \left( \frac{\partial v^*}{\partial t^*} + u^* \frac{\partial v^*}{\partial x^*} - w_0^* \frac{\partial v^*}{\partial z^*} \right) = \mu \left( \frac{\partial^2 v^*}{\partial x^{*2}} + \frac{\partial^2 v^*}{\partial z^{*2}} \right) - \frac{\partial uw}{\partial x} - \frac{\delta\psi\mu_e^2 H_0^2 (v - mw)}{1 + m^2} \quad (18)$$

If electrical dissipation function and electromagnetic dissipation terms are neglected the energy equation becomes,

$$\frac{\partial T^*}{\partial t^*} + u^* \frac{\partial T^*}{\partial x^*} - w_0^* \frac{\partial T^*}{\partial z^*} = \frac{k}{\rho c_p} \left( \frac{\partial^2 T}{\partial x^{*2}} + \frac{\partial^2 T}{\partial z^{*2}} \right) + \phi + \frac{Q^+}{\rho c_p} \quad (19)$$

Finally the concentration equation is given by,

$$\frac{\partial C^*}{\partial t^*} + u^* \frac{\partial C^*}{\partial x^*} - w_0^* \frac{\partial C^*}{\partial z^*} = D \left( \frac{\partial^2 C^*}{\partial x^{*2}} + \frac{\partial^2 C^*}{\partial z^{*2}} \right) \quad (20)$$

Turbulent flow is defined as an eddying motion in which the various quantities show random variation with time and space coordinates, so that statistically distinct average values can be discerned (Hinze 1974, Reynolds 1976). The basic nature of turbulence can be described as a wide spectrum of various sized vortex elements which interact with each other in a highly random and unsteady fashion. That is

$$\rho = \bar{\rho} + \rho', \quad u_j = \bar{u}_j + u'_j, \quad p = \bar{p} + p'$$

Thus the continuity equation reduces to

$$\frac{\partial \bar{\rho}}{\partial t} + \frac{\partial}{\partial x_j} (\overline{\rho u_j}) + \frac{\partial}{\partial x_j} (\overline{\rho' u'_j}) = 0 \quad (21)$$

Averaging and adopting the Boussinesque approximation on the shear stress terms

$$\frac{\partial(\bar{u}^* \bar{v}^*)}{\partial x^*}, \frac{\partial(\bar{u}^* \bar{w}^*)}{\partial x^*}$$

$$\tau = -\rho \bar{v} \bar{w} = A \frac{\partial \bar{v}}{\partial z} \quad (24)$$

From experiment Prandtl deduced that;

$$\rho \bar{v} \bar{w} = -\rho l^2 \left( \frac{\partial \bar{v}}{\partial z} \right)^2 \quad (25)$$

Taking  $l = kz$  where  $k$  is the Von Karman constant so we have;

$$\bar{u}^* \bar{v}^* = -k^2 x^2 \left( \frac{\partial \bar{v}^*}{\partial x^*} \right)^2 \quad (26)$$

$$\bar{u}^* \bar{w}^* = -k^2 x^2 \left( \frac{\partial \bar{w}^*}{\partial x^*} \right)^2 \quad (27)$$

Substituting in equations (17) and (18) we get

$$\frac{\partial \bar{u}^*}{\partial t^*} + \bar{u}^* \frac{\partial \bar{u}^*}{\partial x^*} - \bar{w}_0^* \frac{\partial \bar{u}^*}{\partial z^*} = \frac{\mu}{\rho} \left( \frac{\partial^2 \bar{u}^*}{\partial x^{*2}} + \frac{\partial^2 \bar{u}^*}{\partial z^{*2}} \right) + \beta (T^* - T_\infty^*)$$

$$+ \beta' (C^* - C_\infty^*) - \frac{\partial}{\partial x^*} \left[ k^2 x^2 \left( \frac{\partial \bar{v}^*}{\partial x^*} \right)^2 \right] - \frac{\delta \psi \mu_e^2 H_0^2 (m \bar{v}^* - \bar{w}^*)}{\rho (1+m)^2} \quad (28)$$

$$\frac{\partial \bar{v}^*}{\partial t^*} + \bar{u}^* \frac{\partial \bar{v}^*}{\partial x^*} - \bar{w}_0^* \frac{\partial \bar{v}^*}{\partial z^*} = \frac{\mu}{\rho} \left( \frac{\partial^2 \bar{v}^*}{\partial x^{*2}} + \frac{\partial^2 \bar{v}^*}{\partial z^{*2}} \right)$$

$$- \frac{\partial}{\partial x^*} \left[ k^2 x^2 \left( \frac{\partial \bar{w}^*}{\partial x^*} \right)^2 \right] - \frac{\delta \psi \mu_e^2 H_0^2 (v^* - m \bar{w}^*)}{\rho (1+m)^2}$$

(29)

It is assumed that the induced magnetic field is negligible so that the fluid is permeated by a strong field  $\vec{H} = (H_0 \sqrt{1-\psi^2}, 0, H_0 \psi)$  where  $H_0 = |H|$  is the magnitude of the magnetic field and  $\psi = \cos \theta$ . This assumption hold for small magnetic Reynold's number. The equation of Electric charge  $\nabla \cdot J = 0$  gives  $J_{z^*} = \text{const}$ ; this constant is assumed to be zero, since  $J_{z^*} = 0$  at the plate, which is electrically non-conducting. It implies that  $J_{z^*} = 0$  everywhere in the flow. Taking

into consideration the Hall current (due to electrons), Ion-slip current (due to ions) and collisions between electrons and neutral particles, we obtain a modified Ohm's law of the form,

$$J = \sigma[E + q \times B] - \frac{\omega_e \tau_e}{B_0} [J \times B] + \frac{\omega_e \tau_e \omega_i \tau_i}{B_0^2} (J \times B) \times B \quad (30)$$

For short circuit problem the applied electric field  $E = 0$ . Equation (30) becomes

$$J = \sigma[q \times B] - \frac{\omega_e \tau_e}{B_0} [J \times B] + \frac{\omega_e \tau_e \omega_i \tau_i}{B_0^2} (J \times B) \times B \quad (31)$$

Solving (31) for  $J_{x^*}$  and  $J_{y^*}$  yields,

$$J_{x^*} = \frac{\sigma \mu_e H_0 \psi [v^* (1 + m_* n_* \psi^2) + u^* m_* \psi]}{[1 + m_* n_* \psi^2]^2 + m_*^2 \psi^2} \quad (32)$$

$$J_{y^*} = \frac{\sigma \mu_e H_0 \psi [v^* m_* \psi - u^* (1 + m_* n_* \psi^2)]}{[1 + m_* n_* \psi^2]^2 + m_*^2 \psi^2} \quad (33)$$

Where  $m_* = \omega_e \tau_e$  (Hall parameter) and  $n_* = \omega_i \tau_i$  (Ion-slip parameter).

Substituting equation (32) and (33) in equation (28) and (29) from equations we obtain,

$$\begin{aligned} \rho \left( \frac{\partial u^*}{\partial t^*} + u^* \frac{\partial u^*}{\partial x^*} - w_0^* \frac{\partial u^*}{\partial z^*} \right) &= \mu \left( \frac{\partial^2 u^*}{\partial x^{*2}} + \frac{\partial^2 u^*}{\partial z^{*2}} \right) + \beta \rho (T^* - T_\infty^*) \\ &+ \beta' \rho (C^* - C_\infty^*) - \frac{\partial uv}{\partial x} + \frac{\sigma \mu_e^2 H_0^2 \psi^2 [v^* m_* \psi - u^* (1 + m_* n_* \psi^2)]}{[1 + m_* n_* \psi^2]^2 + m_*^2 \psi^2} \end{aligned} \quad (34)$$

$$\begin{aligned} \rho \left( \frac{\partial v^*}{\partial t^*} + u^* \frac{\partial v^*}{\partial x^*} - w_0^* \frac{\partial v^*}{\partial z^*} \right) &= \mu \left( \frac{\partial^2 v^*}{\partial x^{*2}} + \frac{\partial^2 v^*}{\partial z^{*2}} \right) - \frac{\partial uv}{\partial x} \\ &- \frac{\sigma \mu_e^2 H_0^2 \psi^2 [v^* m_* \psi - u^* (1 + m_* n_* \psi^2)]}{[1 + m_* n_* \psi^2]^2 + m_*^2 \psi^2} \end{aligned} \quad (35)$$

$$\begin{aligned} \frac{\partial T^*}{\partial t^*} + u^* \frac{\partial T^*}{\partial x^*} - w_0^* \frac{\partial T^*}{\partial z^*} &= \frac{k}{\rho c_p} \left( \frac{\partial^2 T^*}{\partial x^{*2}} + \frac{\partial^2 T^*}{\partial z^{*2}} \right) + \frac{Q^+}{\rho c_p} \\ &+ \frac{v}{\rho c_p} \left[ \left( \frac{\partial u^*}{\partial x^*} \right)^2 + \left( \frac{\partial v^*}{\partial x^*} \right)^2 + \left( \frac{\partial u^*}{\partial z^*} \right)^2 + \left( \frac{\partial v^*}{\partial z^*} \right)^2 \right] \end{aligned} \quad (36)$$

And

$$\frac{\partial C^*}{\partial t^*} + u^* \frac{\partial C^*}{\partial x^*} - w_0^* \frac{\partial C^*}{\partial z^*} = D \left( \frac{\partial^2 C^*}{\partial x^{*2}} + \frac{\partial^2 C^*}{\partial z^{*2}} \right) \quad (37)$$

The following Non Dimensional numbers are used in this paper;

### **Raynold's number, Re**

It is the ratio of inertia force to the viscous force acting on the fluid. If for any flow this number is less than one the inertia force is negligible and on the other hand if it is large, one can ignore viscous force and so the fluid can be taken as inviscid. It is given by

$$\text{Re} = \frac{\rho UL}{\mu} = \frac{UL}{\nu}$$

It plays a role in forced convection; its role is the same as that of Grashof number in natural/free convection.

Its critical value governs the transition from laminar to turbulent in forced convection.

### **Prandtl number, Pr**

It is the ratio of viscous force to thermal force acting on the fluid. It relates the velocity field with temperature field, and is the ratio of the transport properties  $\nu$  and  $\alpha$ , which govern the transport of momentum and energy respectively. It plays a role in heat transfer.

The Prandtl number is large when thermal conductivity is less than one and viscosity is large, and is small when viscosity is less than one and thermal conductivity is large.

$$\text{Pr} = \frac{\nu}{\alpha}; \quad \alpha = \frac{k}{\rho c}$$

$\nu$  – momentum (kinematic diffusivity)

$\alpha$  – thermal diffusivity

$$\text{Or } \text{Pr} = \frac{\mu c_p}{k}$$

### **Grashof number, Gr**

This is another non-dimensional number, which usually occurs in natural convection problems. It is due to density differences resulting from concentration difference and not temperature differences and defined as the ratio of buoyancy forces to viscous forces acting on the fluid. Its critical value governs the transition from laminar to turbulent flow in natural/free convection.

The larger it is the stronger is the convective current.

$$Gr = \frac{vg\beta(T_w^* - T_\infty^*)}{U^3}$$

### **Eckert number, Ec**

This is the ratio of the kinetic energy to thermal energy.

$$Ec = \frac{U^2}{c_p(T_w^* - T_\infty^*)}$$

### **Hartmann number, M**

It is the ratio of magnetic force to the viscous force,

$$M^2 = \frac{\sigma\mu_e^2 H_0^2 \nu}{U\rho}$$

### **Schmidt number, Sc**

This provides a measure of the relative effectiveness of momentum and mass transport by diffusion in the velocity field and concentration boundary layers respectively.

It relates the velocity field with the concentration field, and is the ratio of the transport properties  $\nu$  and  $D$ , which govern the transport of momentum and mass respectively.

Plays a role in mass transfer; its role in mass transfer is the same as that of Prandtl number in heat transfer.

$$Sc = \frac{\nu}{D}$$

$\nu$  – momentum (kinematic) diffusivity

$D$  – mass diffusivity

### Nusselt number, Nu

This parameter is equal to the dimensionless temperature gradient at the surface. It provides a measure of the convection heat transfer occurring at the surface.

$$Nu = \frac{\delta\theta}{\delta x} \Big|_{x=0}$$

### Sherwood number, Sh

Is the dimensionless concentration gradient at the surface. It provides a measure of the convection mass transfer occurring at the surface.

$$Sh = \frac{\delta C}{\delta x} \Big|_{x=0}$$

In this study, all the variables with the superscript (\*) star will represent dimensional variables and non-dimensionalization is based on the following sets of scaling variables.

On introducing the dimensionless quantities

$$\begin{aligned} t &= \frac{t^* U^2}{\nu}, \quad x = \frac{x^* U}{\nu}, \quad z = \frac{z^* U}{\nu}, \quad u = \frac{u^*}{U}, \quad v = \frac{v^*}{U}, \quad w_0 = \frac{w_0^*}{U}, \\ \tau &= \frac{\tau^*}{\rho U}, \quad \theta = \frac{T^* - T_\infty^*}{T_w^* - T_\infty^*}, \quad C = \frac{C^* - C_\infty^*}{C_w^* - C_\infty^*}, \quad Sc = \frac{D}{\nu}, \quad \delta = \frac{Q\nu}{kU^2}, \\ Gr &= \frac{\nu g \beta (T_w^* - T_\infty^*)}{U^3}, \quad Gc = \frac{\nu g \beta' (C_w^* - C_\infty^*)}{U^3} \end{aligned} \quad (38)$$

Equations (34) to (37) becomes,

$$\begin{aligned} \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} - w_0 \frac{\partial u}{\partial z} &= \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial z^2} \right) + Gr\theta + GcC \\ &- \left[ 2k^2 x \left( \frac{\partial v}{\partial x} \right)^2 + 2k^2 x^2 \left( \frac{\partial^2 v}{\partial x^2} \right) \left( \frac{\partial v}{\partial x} \right) \right] + \frac{M^2 \psi^2 [vm_* \psi - u(1 + m_* n_* \psi^2)]}{[1 + m_* n_* \psi^2]^2 + m_*^2 \psi^2} \end{aligned} \quad (39)$$

$$\begin{aligned} \frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} - w_0 \frac{\partial v}{\partial z} &= \left( \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial z^2} \right) - \left[ 2k^2 x \left( \frac{\partial v}{\partial x} \right)^2 + 2k^2 x^2 \left( \frac{\partial^2 v}{\partial x^2} \right) \left( \frac{\partial v}{\partial x} \right) \right] \\ &- \frac{M^2 \psi^2 [um_* \psi + v(1 + m_* n_* \psi^2)]}{[1 + m_* n_* \psi^2]^2 + m_*^2 \psi^2} \end{aligned} \quad (40)$$

$$\frac{\partial \theta}{\partial t} + u \frac{\partial \theta}{\partial x} - w_0 \frac{\partial \theta}{\partial z} = \frac{1}{Pr} \left[ \frac{\partial^2 \theta}{\partial x^2} + \frac{\partial^2 \theta}{\partial z^2} \right] - \frac{\sigma}{Pr} \theta + Ec \left[ \left( \frac{\partial u}{\partial x} \right)^2 + \left( \frac{\partial v}{\partial x} \right)^2 + \left( \frac{\partial u}{\partial z} \right)^2 + \left( \frac{\partial v}{\partial z} \right)^2 \right] \quad (41)$$

and

$$\frac{\partial C}{\partial t} + u \frac{\partial C}{\partial x} - w_0 \frac{\partial C}{\partial z} = \frac{1}{Sc} \left( \frac{\partial^2 C}{\partial x^2} + \frac{\partial^2 C}{\partial z^2} \right) \quad (42)$$

Initial and boundary conditions in non-dimensional form are,

For

$$\left. \begin{aligned} t \leq 0, u(z, x, 0) = 0, v(z, x, 0) = 0 \\ \theta(z, x, 0) = 0, C(z, x, 0) = 0 \end{aligned} \right\} \quad (43)$$

For

$$\left. \begin{aligned} t > 0, u(0, x, t) = 1, v(0, x, t) = 0 \\ \theta(0, x, t) = 1, C(0, x, t) = 1 \end{aligned} \right\} \quad (44)$$

For

$$\left. \begin{aligned} t > 0, u(\infty, x, t) = 0, v(\infty, x, t) = 0 \\ \theta(\infty, x, t) = 0, C(\infty, x, t) = 0 \end{aligned} \right\} \quad (45)$$

### Method of solution

Equations (39) to (42) are highly non-linear and therefore exact solutions are not possible, in order to solve these equations a fast and stable method for the solution of finite difference approximation has been developed together with the initial and boundary condition (43) to (45).

The profiles given by  $u_{(k,i)}^{n+1}$ ,  $v_{(k,i)}^{n+1}$ ,  $\theta_{(k,i)}^{n+1}$  and  $C_{(k,i)}^{n+1}$  are computed by the following algorithms,

$$u_{(k,i)}^{n+1} = \Delta t \left\{ \begin{aligned} & -u_{(k,i)}^n \left[ \frac{u_{(k,i+1)}^n - u_{(k,i-1)}^n}{2\Delta x} \right] + w_0 \left[ \frac{u_{(k+1,i)}^n - u_{(k-1,i)}^n}{2\Delta z} \right] + \frac{u_{(k+1,i)}^n - 2u_{(k,i)}^n + u_{(k-1,i)}^n}{(\Delta z)^2} \\ & + \frac{u_{(k,i+1)}^n - 2u_{(k,i)}^n + u_{(k,i-1)}^n}{(\Delta x)^2} + Gr\theta_{(k,i)}^n + GcC_{(k,i)}^n - 2k^2 i \Delta x \left( \frac{u_{(k,i+1)}^n - 2u_{(k,i)}^n + u_{(k,i-1)}^n}{2\Delta x} \right)^2 \\ & - 2k^2 (i\Delta x)^2 \left( \frac{u_{(k,i+1)}^n - 2u_{(k,i)}^n + u_{(k,i-1)}^n}{(\Delta x)^2} \right)^2 \left( \frac{u_{(k,i+1)}^n - u_{(k,i)}^n}{2\Delta x} \right) \\ & - \frac{M^2 \psi^2 [v_{(k,i)}^n m_* \psi - u_{(k,i)}^n (1 + m_* n_* \psi^2)]}{[1 + m_* n_* \psi^2]^2 + m_*^2 \psi^2} \end{aligned} \right\} + u_{(k,i)}^n$$

(46)

$$v_{(k,i)}^{n+1} = \Delta t \left\{ \begin{aligned} & -u_{(k,i)}^n \left[ \frac{v_{(k,i+1)}^n - v_{(k,i-1)}^n}{2\Delta x} \right] + w_0 \left[ \frac{v_{(k+1,i)}^n - v_{(k-1,i)}^n}{2\Delta z} \right] + \frac{v_{(k+1,i)}^n - 2v_{(k,i)}^n + v_{(k-1,i)}^n}{(\Delta z)^2} \\ & + \frac{v_{(k,i+1)}^n - 2v_{(k,i)}^n + v_{(k,i-1)}^n}{(\Delta x)^2} - 2k^2 i \Delta x \left( \frac{u_{(k,i+1)}^n - 2u_{(k,i)}^n + u_{(k,i-1)}^n}{2\Delta x} \right)^2 \\ & - 2k^2 (i\Delta x)^2 \left( \frac{u_{(k,i+1)}^n - 2u_{(k,i)}^n + u_{(k,i-1)}^n}{(\Delta x)^2} \right)^2 \left( \frac{u_{(k,i+1)}^n - u_{(k,i)}^n}{2\Delta x} \right) \\ & - \frac{M^2 \psi^2 \left[ u_{(k,i)}^n m_* \psi + v_{(k,i)}^n (1 + m_* n_* \psi^2) \right]}{\left[ 1 + m_* n_* \psi^2 \right]^2 + m_*^2 \psi^2} \end{aligned} \right\} + u_{(k,i)}^n$$

(47)

$$\begin{aligned} & \frac{\theta_{(k,i)}^{n+1} - \theta_{(k,i)}^n}{\Delta t} + u_{(k,i)}^n \left[ \frac{\theta_{(k,i+1)}^n - \theta_{(k,i-1)}^n}{2\Delta x} \right] - w_0 \frac{\theta_{(k+1,i)}^n - \theta_{(k-1,i)}^n}{2\Delta z} = \frac{1}{\text{Pr}} \left[ \frac{\theta_{(k,i+1)}^n - 2\theta_{(k,i)}^n + \theta_{(k,i-1)}^n}{(\Delta x)^2} \right] \\ & + \frac{1}{\text{Pr}} \left[ \frac{\theta_{(k+1,i)}^n - 2\theta_{(k,i)}^n + \theta_{(k-1,i)}^n}{(\Delta z)^2} \right] - \frac{\sigma}{\text{Pr}} \theta_{(k,i)}^n + Ec \left[ \begin{aligned} & \left( \frac{u_{(k,i+1)}^n - u_{(k,i-1)}^n}{2\Delta x} \right)^2 + \left( \frac{v_{(k,i+1)}^n - v_{(k,i-1)}^n}{2\Delta x} \right)^2 \\ & + \left( \frac{u_{(k+1,i)}^n - u_{(k-1,i)}^n}{2\Delta z} \right)^2 + \left( \frac{v_{(k+1,i)}^n - v_{(k-1,i)}^n}{2\Delta z} \right)^2 \end{aligned} \right] + \theta_{(k,i)}^n \end{aligned}$$

(48)

$$\theta_{(k,i)}^{n+1} = \Delta t \left\{ \begin{aligned} & -u_{(k,i)}^n \left[ \frac{\theta_{(k,i+1)}^n - \theta_{(k,i-1)}^n}{2\Delta x} \right] + w_0 \left[ \frac{\theta_{(k+1,i)}^n - \theta_{(k-1,i)}^n}{2\Delta z} \right] + \frac{1}{\text{Pr}} \frac{\theta_{(k+1,i)}^n - 2\theta_{(k,i)}^n + \theta_{(k-1,i)}^n}{(\Delta z)^2} \\ & + \frac{1}{\text{Pr}} \frac{\theta_{(k,i+1)}^n - 2\theta_{(k,i)}^n + \theta_{(k,i-1)}^n}{(\Delta x)^2} - \frac{\sigma}{\text{Pr}} \theta_{(k,i)}^n + Ec \left[ \begin{aligned} & \left( \frac{u_{(k,i+1)}^n - u_{(k,i-1)}^n}{2\Delta x} \right)^2 + \left( \frac{v_{(k,i+1)}^n - v_{(k,i-1)}^n}{2\Delta x} \right)^2 \\ & + \left( \frac{u_{(k+1,i)}^n - u_{(k-1,i)}^n}{2\Delta z} \right)^2 + \left( \frac{v_{(k+1,i)}^n - v_{(k-1,i)}^n}{2\Delta z} \right)^2 \end{aligned} \right] \end{aligned} \right\} + \theta_{(k,i)}^n$$

(49)

And

$$C_{(k,i)}^{n+1} = \Delta t \left\{ -u_{(k,i)}^n \left[ \frac{C_{(k,i+1)}^n - C_{(k,i-1)}^n}{2\Delta x} \right] + w_0 \left[ \frac{C_{(k+1,i)}^n - C_{(k-1,i)}^n}{2\Delta z} \right] + \frac{1}{Sc} \left[ \left( \frac{C_{(k,i+1)}^n - 2C_{(k,i)}^n + C_{(k,i-1)}^n}{2\Delta x} \right) + \left( \frac{C_{(k+1,i)}^n - 2C_{(k,i)}^n + C_{(k-1,i)}^n}{2\Delta z} \right)^2 \right] \right\} + C_{(k,i)}^n \quad (50)$$

### Calculation of rates of heat transfer, mass transfer and skin friction

1. The skin friction is calculated from velocity profiles using the equations

$$\left\{ \tau_x = -\frac{\partial u}{\partial z} \Big|_{z=0} \quad \text{and} \quad \tau_y = -\frac{\partial v}{\partial z} \Big|_{z=0} \quad \text{where} \quad \tau = \frac{\tau^*}{\rho\mu^2} \right\} \quad (51)$$

2. Rate of mass transfer is calculated from the concentration profile using the equation,

$$Sh = -\frac{\partial C}{\partial z} \Big|_{z=0} \quad (52)$$

The above are calculated by numerical differentiation using Newton's interpolation formula over the first five points,

$$\tau_x = \frac{5}{6} [25u(0, i) - 48u(1, i) + 36u(2, i) - 16u(3, i) + 3u(4, i)] \quad (53)$$

$$\tau_y = \frac{5}{6} [25v(0, i) - 48v(1, i) + 36v(2, i) - 16v(3, i) + 3v(4, i)] \quad (54)$$

$$Sh = \frac{5}{6} [25C(0, i) - 48C(1, i) + 36C(2, i) - 16C(3, i) + 3C(4, i)] \quad (55)$$

The rate of heat transfer is calculated from temperature profiles in terms of the Nusselt number which is given by,

$$Nu = -\frac{1}{\theta_{(0,0)}^{n+1}} \frac{\partial \theta}{\partial z} \Big|_{z=0}$$

But  $\frac{\partial \theta}{\partial z} = -1$  which implies that

$$Nu = \frac{1}{\theta_{(0,0)}^{n+1}} \quad (56)$$

## Discussion of results

A program was written and run for various values of velocities, temperatures and concentration for the finite differences equations (34) to (37) using different values of the parameters  $Sc, m, n, \sigma, \omega, t, Gc, Ec$  and  $\psi$ . The velocities are classified as primary velocities (u) and secondary velocities (v) along the  $x$  and  $y$  axes respectively.

The concentration, velocity and temperature profiles are presented graphically in figures. Grashof number  $Gr > 0, (+0.4)$  corresponding to cooling of the plate by free convection currents and Grashof number  $Gr < 0, (-0.4)$  corresponds to heating of the plate by free convection currents. The magnetic parameter  $M^2 = 5.0$  signifies a strong magnetic field and Prandtl number  $Pr = 0.71$  corresponds to air.

### 5.13.1 Figures and tables for $Pr = 0.71, M^2 = 5.0, Gr = +0.4$ ; with ion-slip

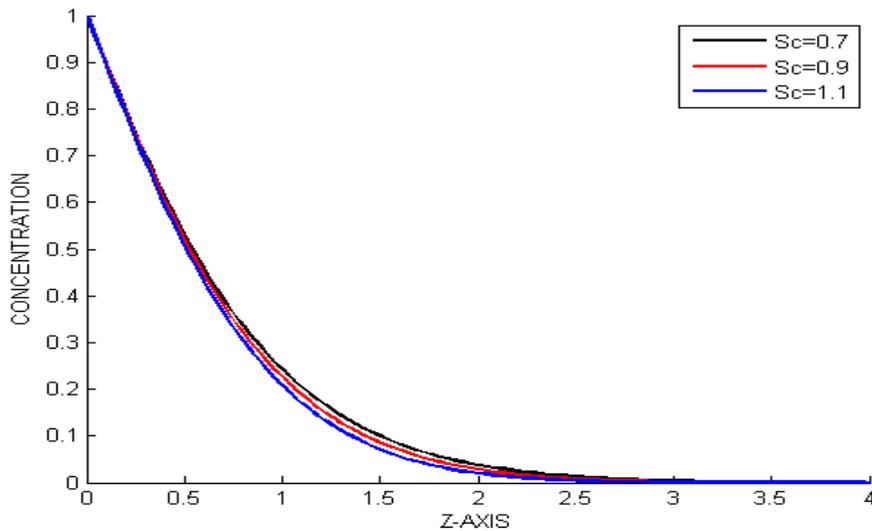


Figure 6.3a: Variation of concentration with Schmidt number  $Sc$ , with ion-slip

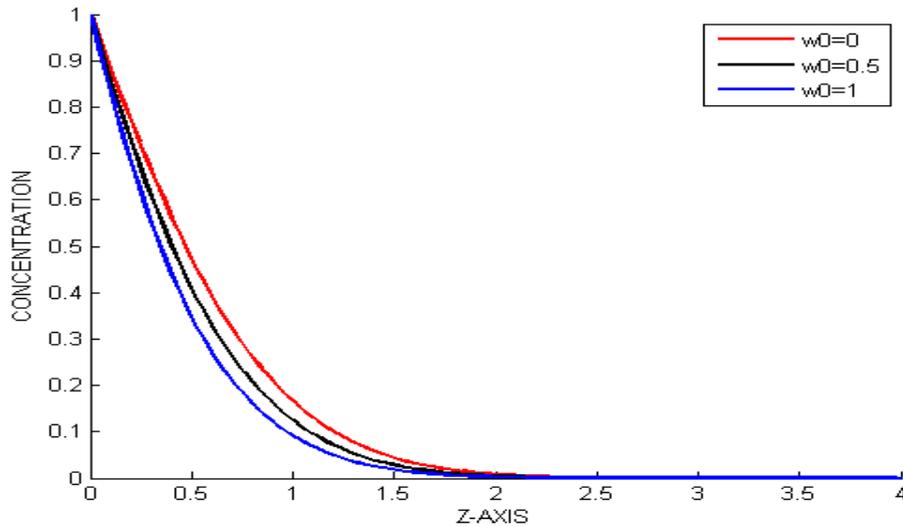


Figure 6.3b: Variation of concentration with Suction velocity  $w_0$ , with ion-slip

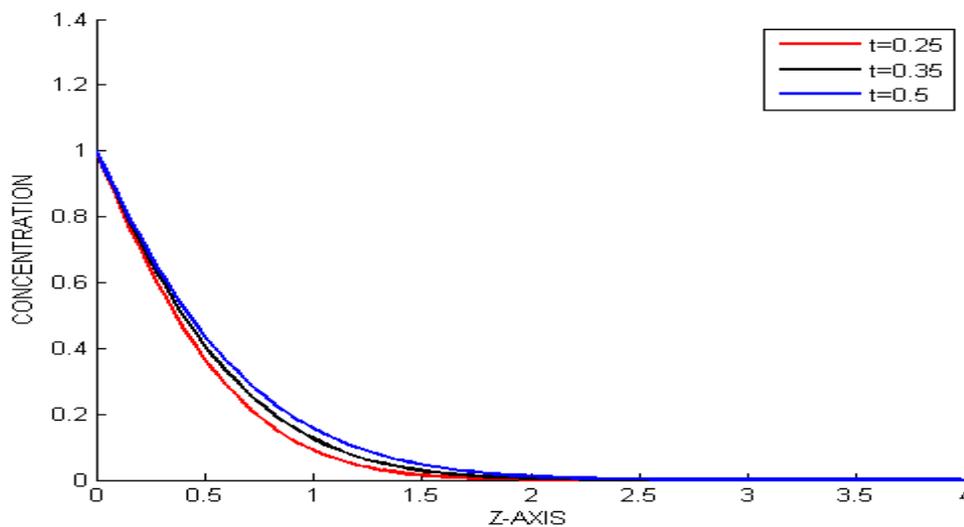


Figure 6.3c: Variation of concentration with time  $t$ , with ion-slip

From figure 6.3a - 6.3c;  $Gr > 0, (+0.4)$ , with ion-slip ( $n$ ); we note that;

- i.) An increase in mass diffusion parameter  $Sc$  causes a decrease in the concentration profiles (figure 6.3a)
- ii.) Removal of suction velocity  $w_0$  leads to an increase in the concentration profiles. This is due to the fact that this increases the growth of the boundary layers and hence the increase in the concentration profiles (figure 6.3b)
- iii.) Increase in time increases the concentration profiles. With time the flow gets to the free stream and therefore its concentration increases (figure 6.3c)

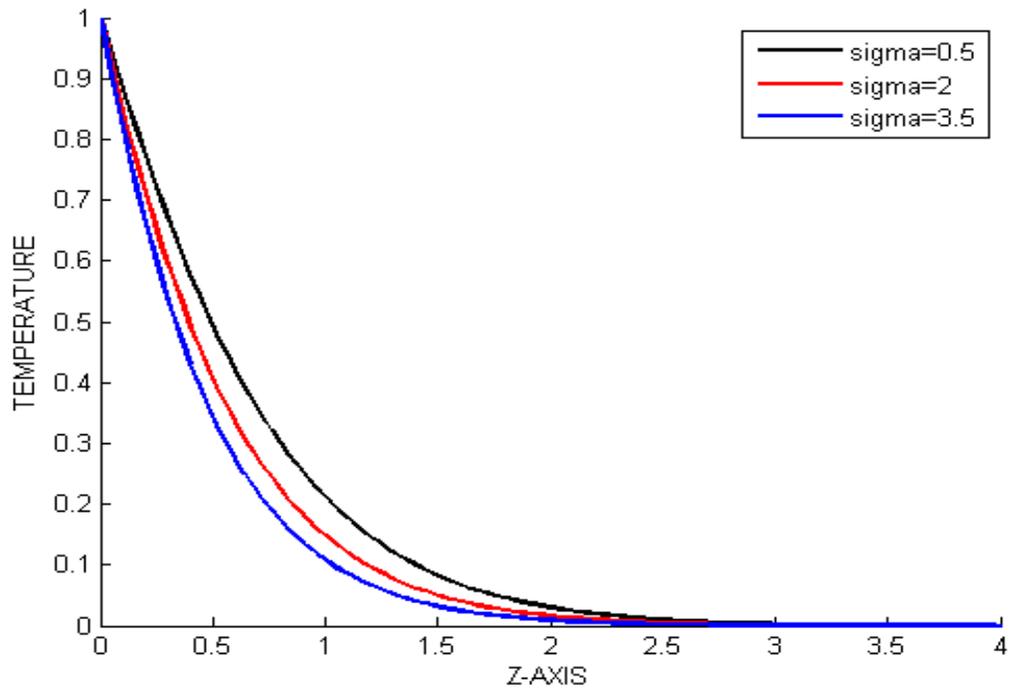


Figure 6.4a: Variation of Temperature with heat source parameter  $\sigma$ , with ion-slip

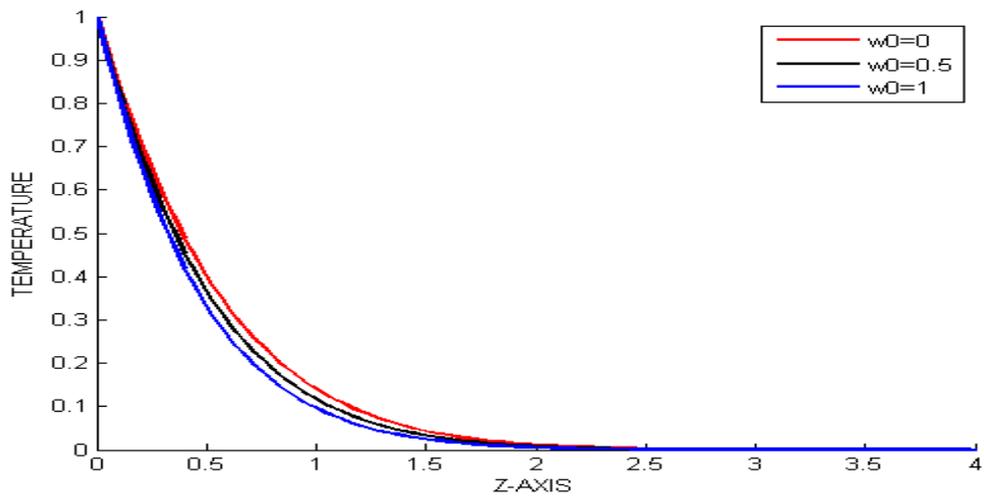


Figure 6.4b: Variation of Temperature with suction velocity  $w_0$ , with ion-slip

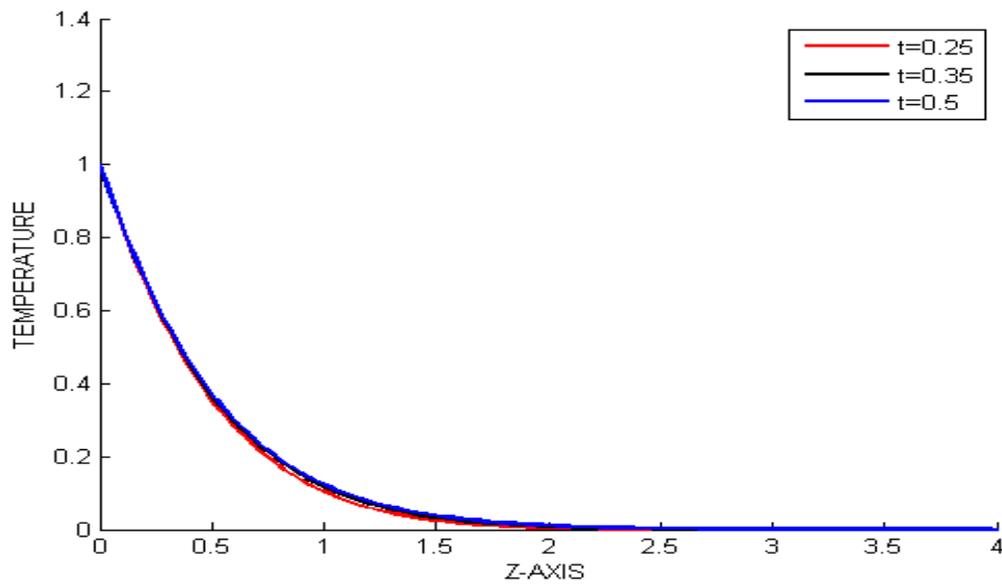


Figure 6.4c: Variation of Temperature with time  $t$  , with ion-slip

From figure 6.4a-6.4c;  $Gr > 0, (+0.4)$  , with ion-slip ( $n$ ); we note that;

- i.) An increase in time  $t$  or a decrease in heat source parameter  $\sigma$  leads to an increase in temperature profiles
- ii.) Removal of suction velocity  $w_0$  causes increase in temperature profiles.
- ii.) Angle of inclination  $\psi$  causes no effect in temperature profiles
- iii.) An increase in ion-slip parameter  $n$  causes no effect in temperature profiles
- iv.) An increase in Hall parameter  $m$  leads to no effect in temperature profiles
- v.) An increase in mass diffusion parameter  $Sc$  causes no effect in temperature profiles.

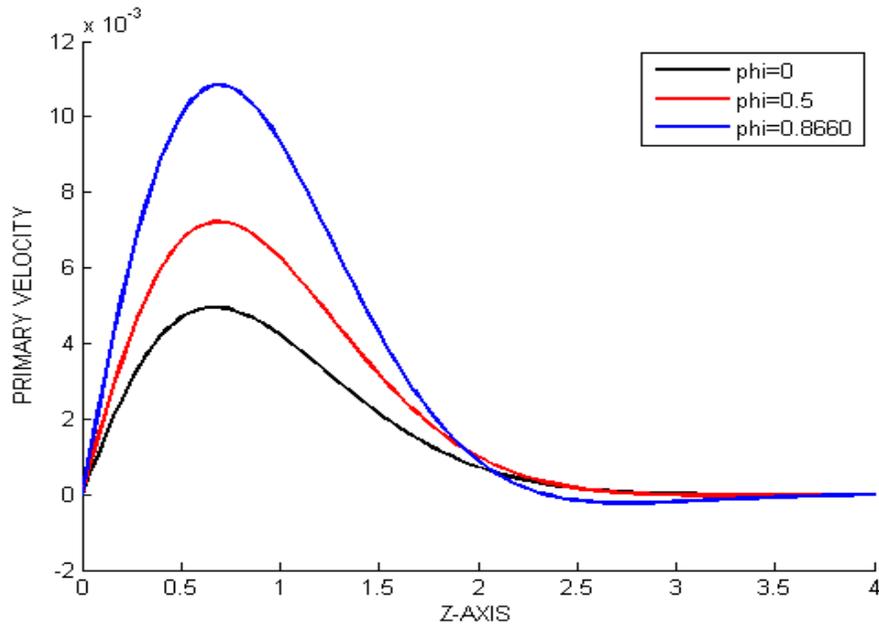


Figure 6.5 a: Variation of Primary velocity with angle of inclination  $\psi$  , with ion-slip

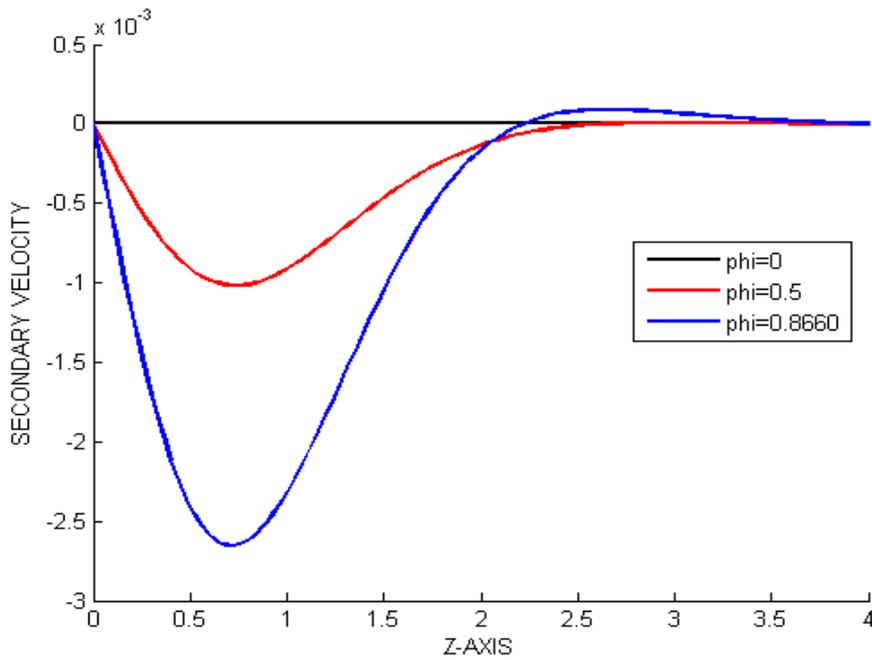


Figure 6.5 b: Variation of Secondary velocity with angle of inclination  $\psi$  , with ion-slip

From figure 6.5 a and 6.5 b;  $Gr > 0, (+0.4)$  with ion-slip (n); we note that;

An increase in the angle of inclination  $\psi$  causes an increase in primary velocity profiles and a decrease in secondary profiles near the plate but away from the plate it decreases primary velocity but increase in secondary velocity to a point where both remain uniformly distributed.

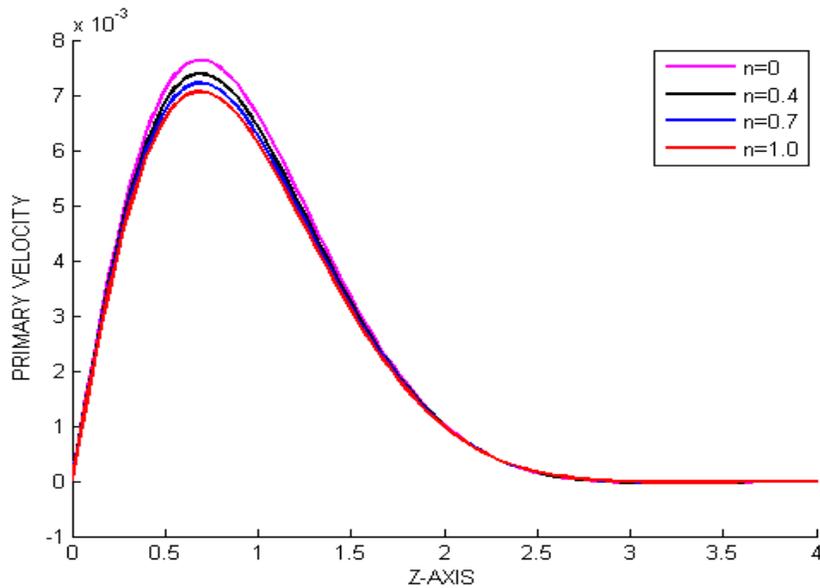


Figure 6.6 a: Variation of Primary velocity with ion-slip  $n$

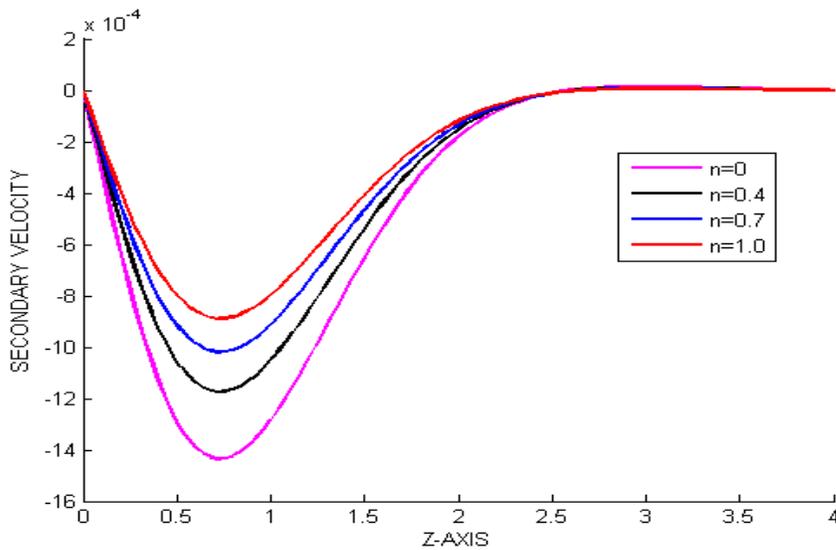


Figure 6.6 b: Variation of Secondary velocity with ion-slip  $n$

From figure 6.6 a and 6.6 b;  $Gr > 0, (+0.4)$  with ion-slip ( $n$ ); we note that;

An increase in ion-slip parameter  $n$  leads to a negligible increase in primary velocity profiles

but a decrease in secondary velocity profiles near the plate and remain constantly distributed away from the plate, this is because increase in ion-slip currents cause the force in the direction of the fluid flow to decrease leading to a decrease in the secondary velocity of the fluid. Since the magnitude of secondary velocity profile is very small, there is a very small increase in primary velocity profile with the change in the ion-slip currents.

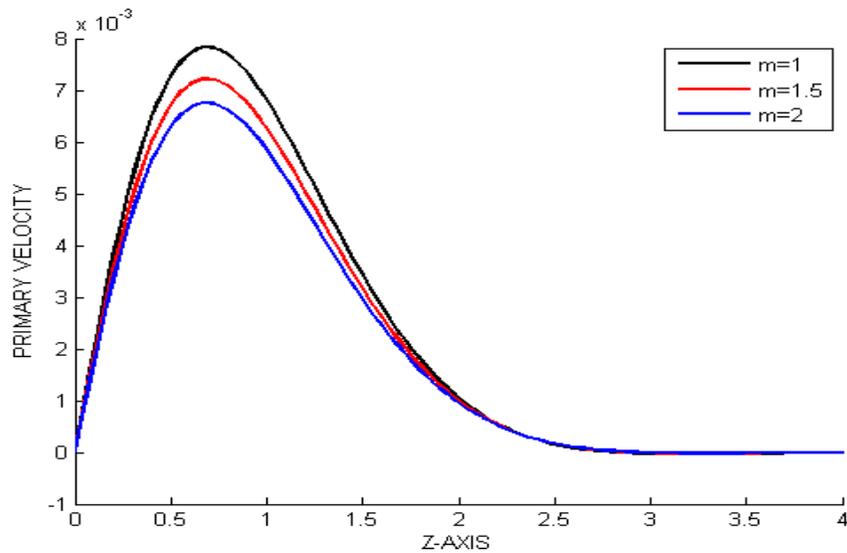


Figure 6.7 a: Variation of Primary velocity with Hall parameter  $m$  , with ion-slip:

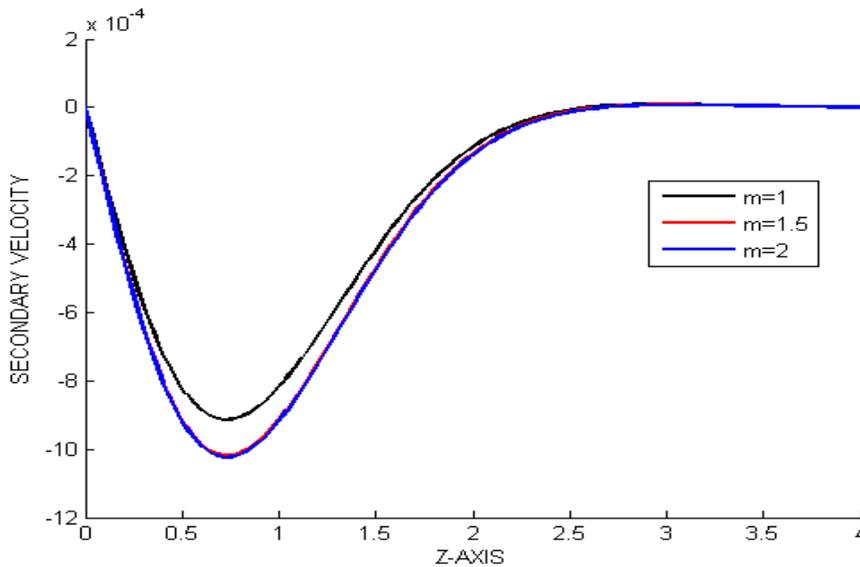


Figure 6.7 b: Variation of Secondary velocity with Hall parameter  $m$  , with ion-slip:

From figure 6.7 a and 6.7 b;  $Gr > 0, (+0.4)$  with ion-slip ( $n$ ); we note that;

An increase in Hall current parameter  $m$  causes a decrease in both primary and secondary velocity profiles.

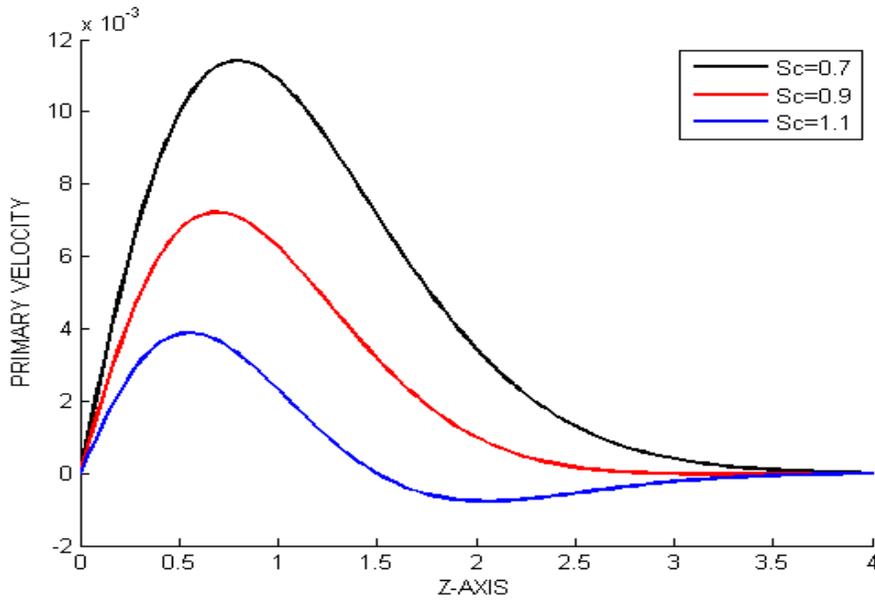


Figure 6.8 a: Variation of Primary velocity with Schmidt number  $Sc$ , with ion-slip

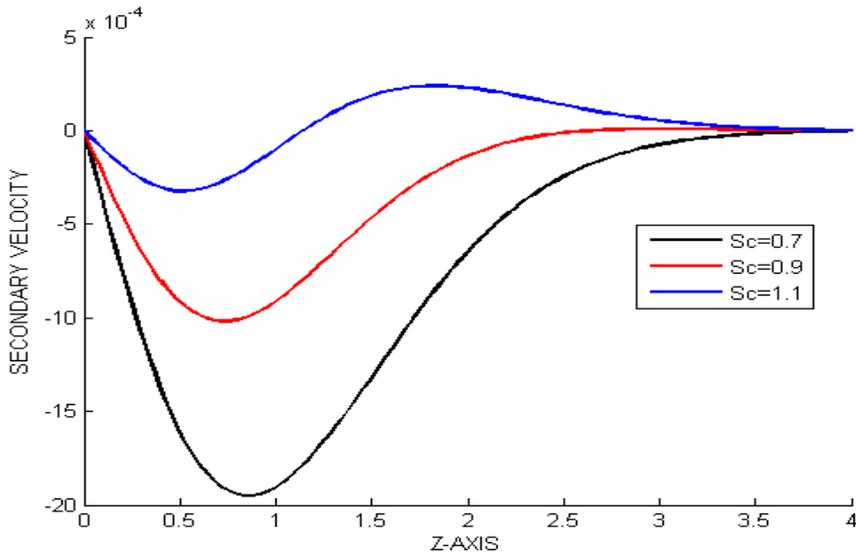


Figure 6.8 b: Variation of Secondary velocity with Schmidt number  $Sc$ , with ion-slip

From figure 6.8 a and 6.8 b;  $Gr > 0, (+0.4)$  with ion-slip ( $n$ ); we note that;

An increase in mass diffusion parameter  $Sc$  leads to a decrease in primary velocity profiles but an increase in secondary velocity profiles near the plate and the velocity profiles remain constantly distributed far away from the plate.

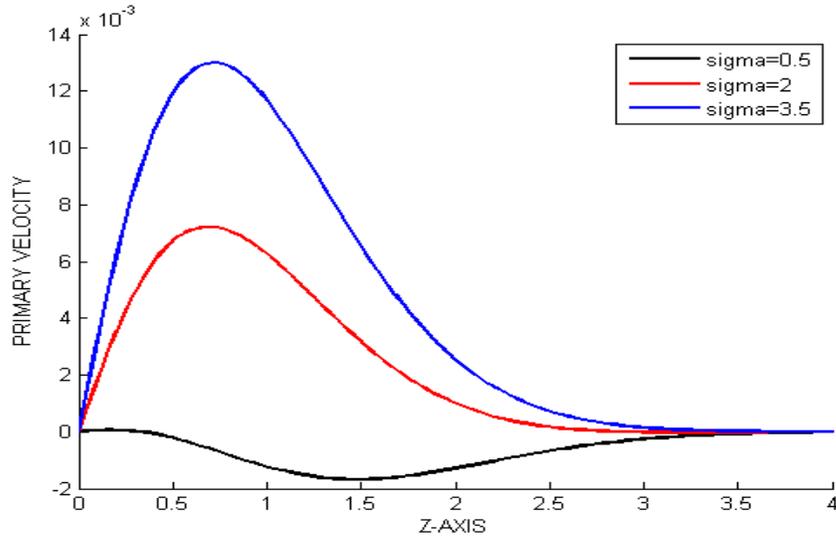


Figure 6.9 a: Variation of Primary velocity with heat source parameter  $\sigma$  , with ion-slip

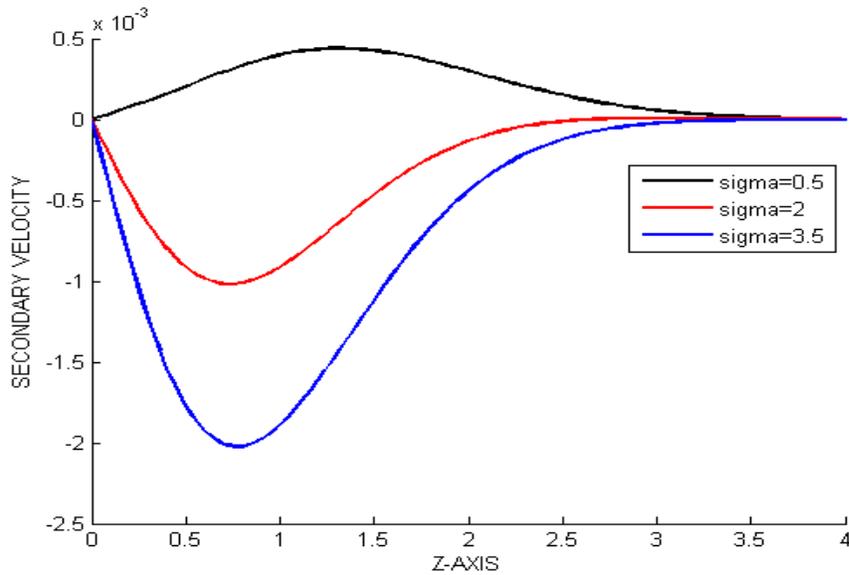


Figure 6.9 b: Variation of Secondary velocity with heat source parameter  $\sigma$  , with ion-slip

From figure 6.5 a and 6.5 b;  $Gr > 0, (+0.4)$  with ion-slip (n); we note that;

An increase in heat source parameter  $\sigma$  leads to a decrease in primary velocity profiles but an increase in secondary velocity profiles near the plate and thereafter remain constantly distributed far away from the plate .

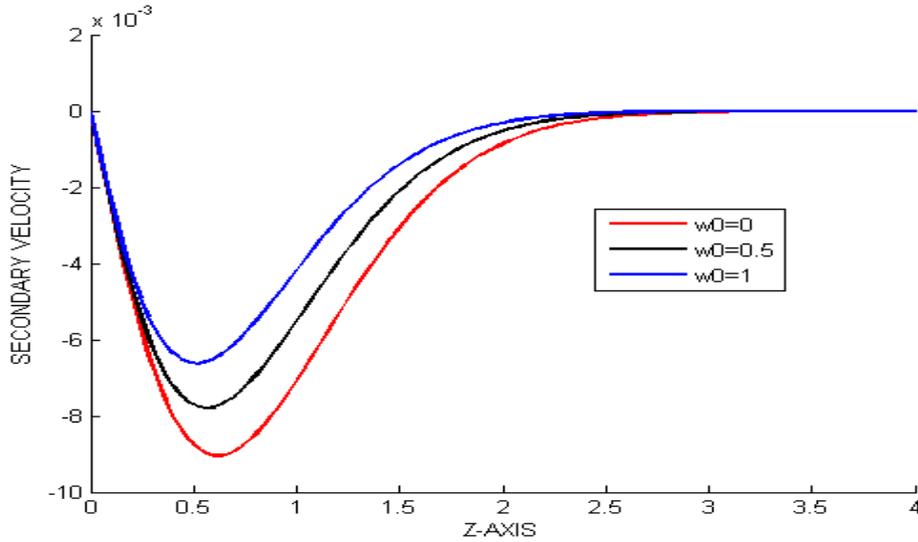


Figure 7.0a: Variation of Secondary velocity with suction velocity  $w_0$ , with ion-slip

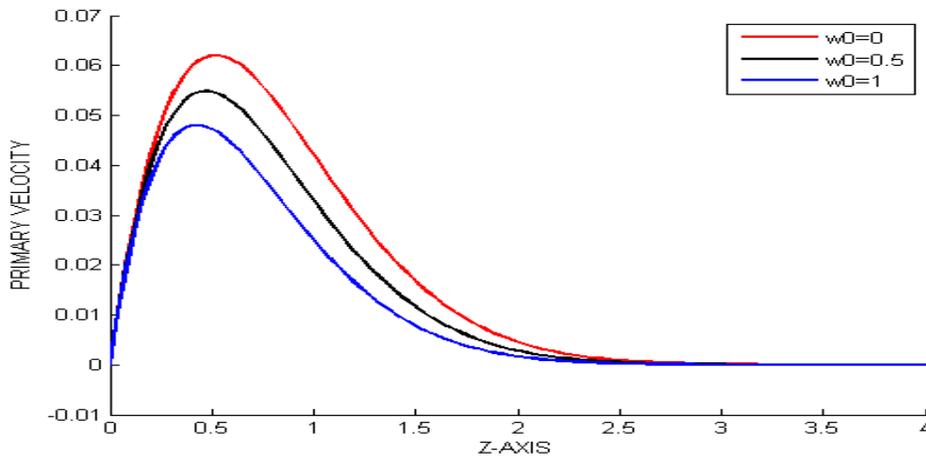


Figure 7.0b: Variation of Primary velocity with suction velocity  $w_0$ , with ion-slip

From the figures 7.0a and 7.0b, we observe that;

- i.) Removal of suction velocity  $w_0$  leads to a gradual increase in primary velocity profiles near the plate to a maximum point after which the primary velocity profiles begin to decrease uniformly then remain constantly distributed far away from the plate in the free stream (figure 7.0b)
- ii.) Removal of suction velocity  $w_0$  leads to a gradual decrease in secondary velocity profiles near the plate to a maximum after which the secondary velocity profiles begin to increase gradually then remain constantly distributed far away from the plate in the free streams (Figure 7.0a)

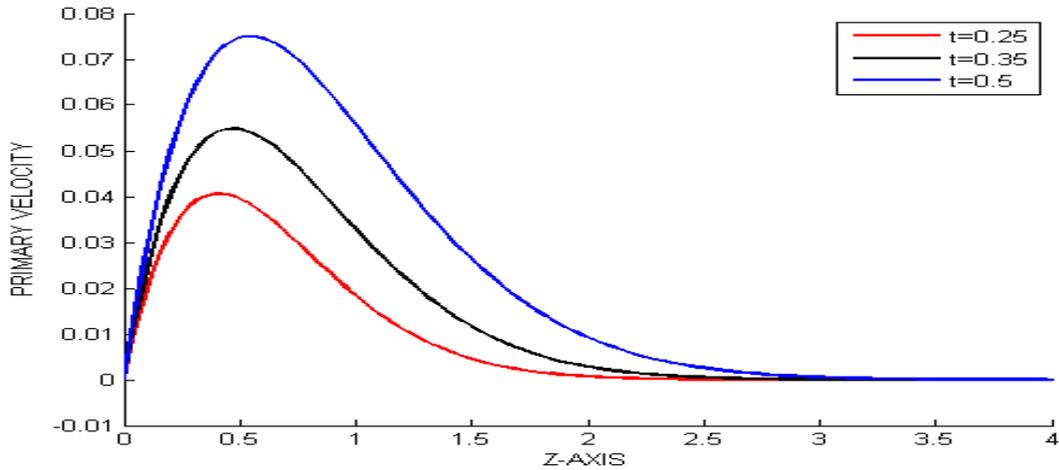


Figure 7.1a: Variation of Primary velocity with time  $t$  , with ion-slip

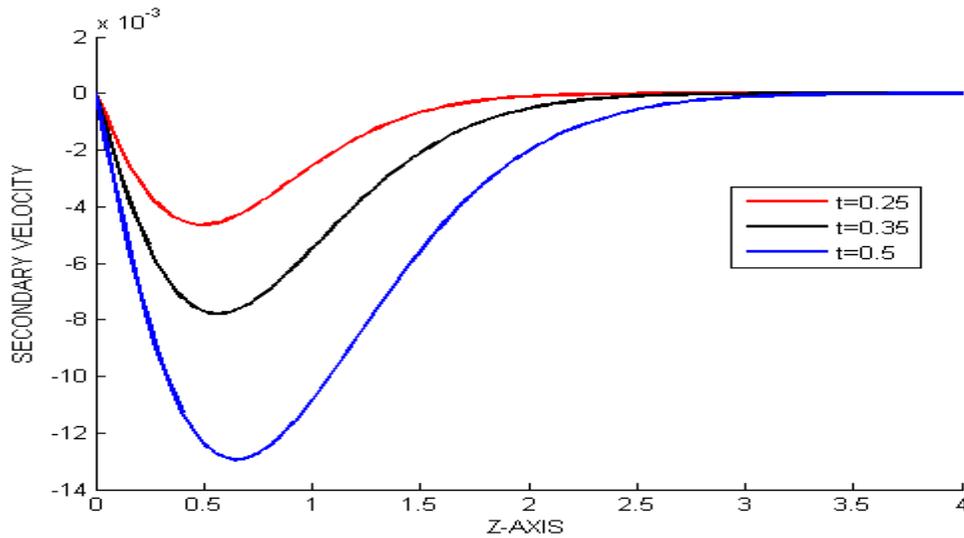


Figure 7.1b: Variation of Secondary velocity with time  $t$  , with ion-slip

From the figures 7.1a and 7.1b,we observe that;

- i.) An increase in time  $t$  increases the primary velocity profiles. With time the flow gets to the free stream and therefore its velocity increases (figure 7.1a)
- ii.) An increase in time  $t$  decreases the secondary velocity profiles. With time the flow gets to the free stream where the secondary velocity diminishes and therefore decrease in velocity profiles (figure 7.1b)

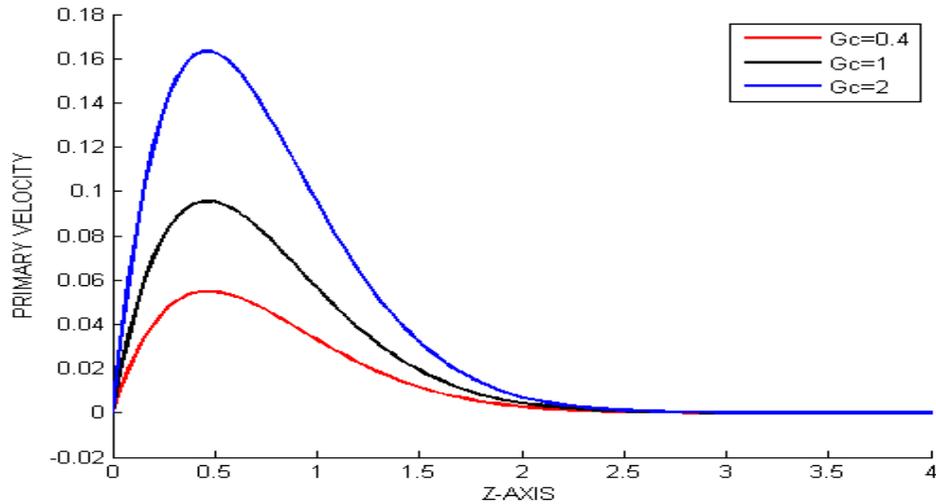


Figure 7.2a: Variation of Primary velocity with Modified Grashof  $G_c$  , with ion-slip

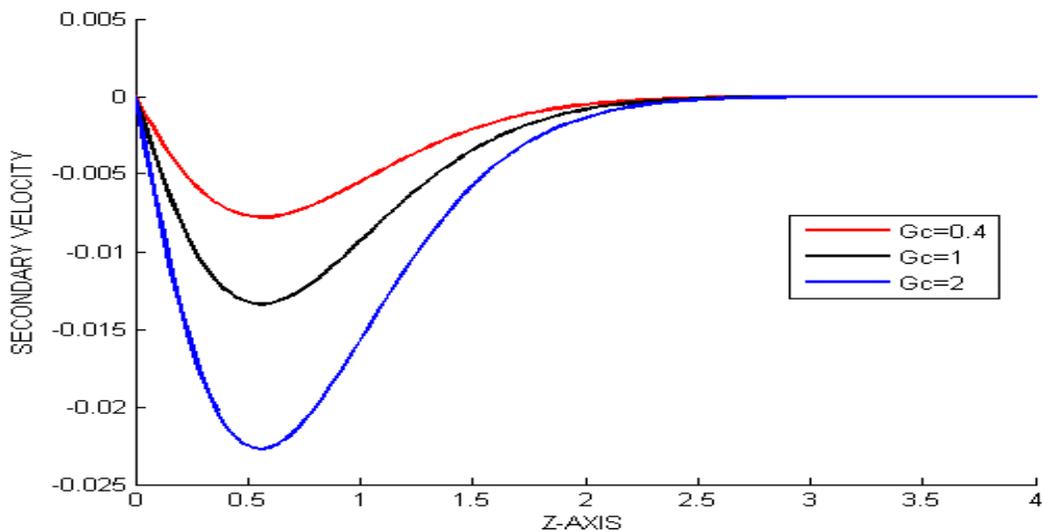


Figure 7.2b: Variation of Secondary velocity with Modified Grashof  $G_c$  , with ion-slip

From the figures 7.1a and 7.1b, we observe that;

- i.) An increase in the Modified Grashof parameter  $G_c$  leads to a gradual increase in primary velocity profiles near the plate to a maximum after which the profiles begin to decrease gradually to a point in the free stream where the distribution remain constant and parallel to the z axis.
- ii.) An increase in the Modified Grashof parameter  $G_c$  leads to a gradual decrease in secondary velocity profiles near the plate to a minimum after which the profiles begin to increase gradually to a point in the free stream where the distribution remain constant and parallel to the z axis.

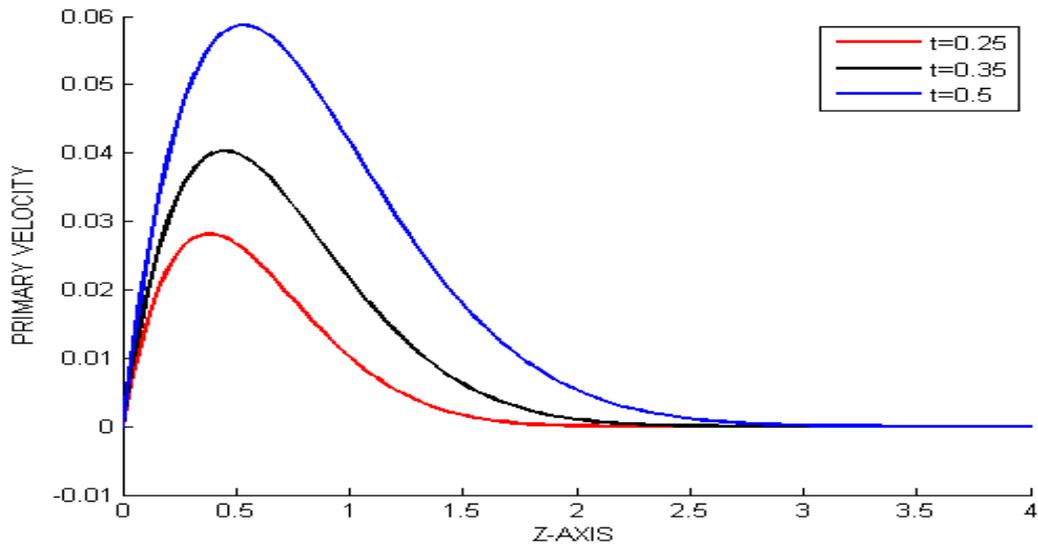


Figure 7.3

a: Variation of Primary velocity with time  $t$ ,  $Gr = -0.4$ , with ion-slip

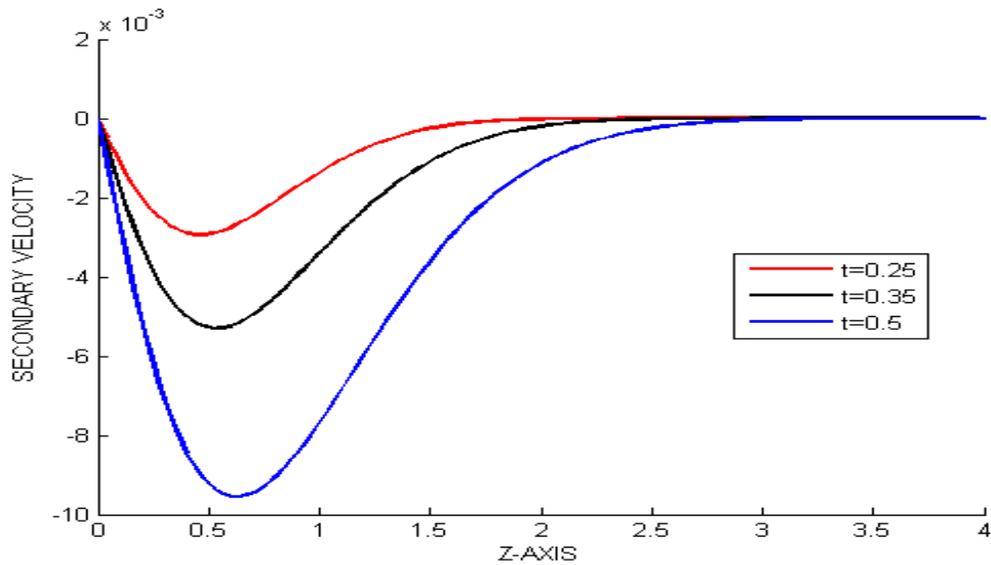


Figure 7.3b: Variation of Secondary velocity with time  $t$ ,  $Gr = -0.4$ , with ion-slip

From figures 7.3a to 7.3b, we observe that;

An increase in time  $t$  leads to an increase in primary velocity profiles but a decrease in secondary velocity profiles from the curves  $t = 0.25$  to  $t = 0.5$  and  $t = 0.5$  to  $0.25$  respectively near the

plate and the velocity remain constantly distributed far away from the plate.

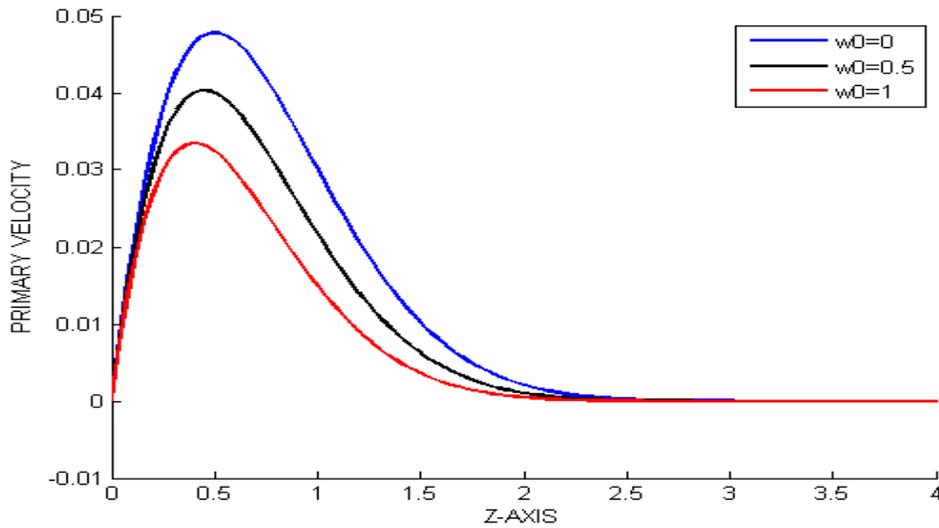


Figure 7.4a: Variation of Primary velocity with Suction velocity  $w_0$ ,  $Gr = -0.4$ , with ion-slip

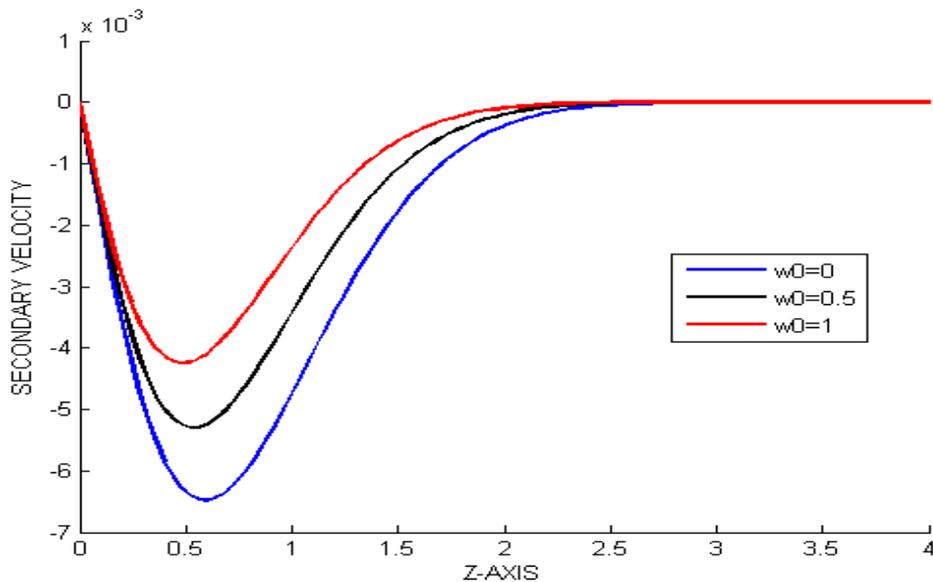


Figure 7.4b: Variation of Secondary velocity with Suction velocity  $w_0$ ,  $Gr = -0.4$ , with ion-slip

From figures 7.4a and 7.4b, we observe that;

- i.) An increase in Hall parameter or removal of suction velocity  $w_0$  causes an increase in primary velocity profiles, this due to the fact that the effective conductivity decreases with the increase in Hall current parameter or removal of suction velocity which reduces the magnetic damping force hence the increase in primary velocity profiles.
- ii.) An increase in Hall current parameter or removal of suction velocity profile causes a decrease

in secondary velocity profiles, this is due to increase in the effective conductivity which increases the magnetic damping force hence the decrease in secondary velocity profiles.

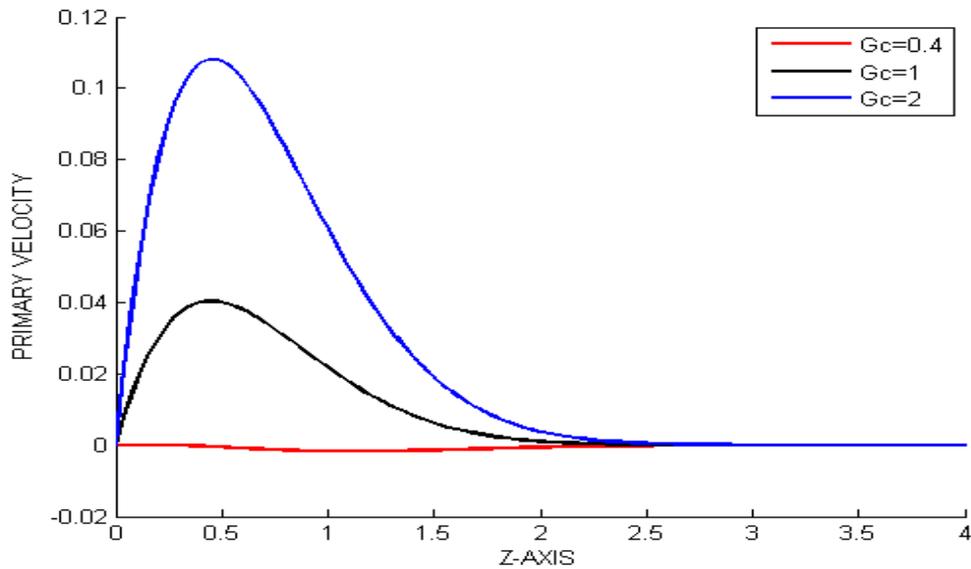


Figure 7.5a: Variation of Primary velocity with Modified Grashof  $G_c, Gr = -0.4$ , with ion-slip

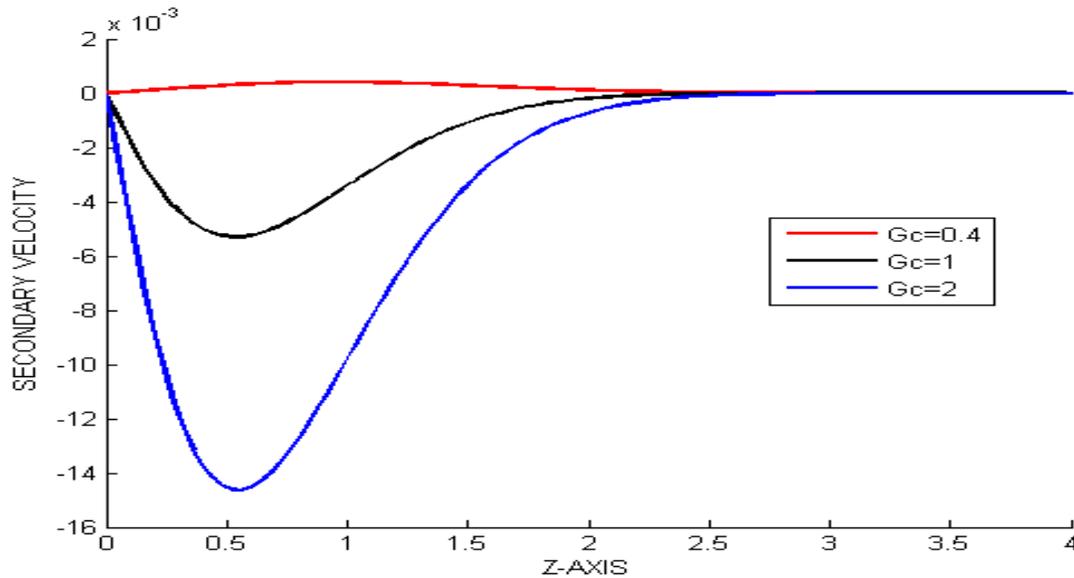


Figure 7.5 b: Variation of Secondary velocity with Modified Grashof  $G_c, Gr = -0.4$ , with ion-slip

From figures 7.5a and 7.5b, we observe that;

- i.) An increase in modified Grashof number  $G_c$  causes an increase in primary velocity profiles but as the distance from the plate increases primary velocity profiles exhibit a decrease and remain parallel to the z-axis far away from the plate.

ii.) An increase in modified Grashof number  $G_c$  causes a decrease in secondary velocity profiles but as the distance from the plate increase secondary velocity profiles exhibit an increase gradually and remain parallel to the  $z$ -axis far away from the plate.

**Table 5.1 Rate of mass transfer,  $Pr = 0.71, M^2 = 5.0, Gr = +0.4$**

$w_0$	Sc	Time	Sh
0	1.1	0.25	2.1109
0.5	1.1	0.25	2.3356
1	1.1	0.25	2.5862
0.5	0.7	0.25	2.202
0.5	0.9	0.25	2.2672
0.5	1.1	0.25	2.3356
0.5	1.1	0.25	2.3958
0.5	1.1	0.35	2.3356
0.5	1.1	0.5	2.295

From Table 5.1, we observe that;

- i.) Removal of suction velocity  $w_0$  causes a decrease in rate of mass transfer  $Sh$
- ii.) Increase in the mass diffusion parameter Sc, leads to an increase in rate of mass transfer  $Sh$
- iii.) Increase in time  $t$  leads to a decrease in rate of mass transfer  $Sh$

**Table 5.2 : Values of skin friction,  $\tau_x$  and  $\tau_y$  for  $Pr = 0.71, M^2 = 5.0, Gr = 0.4$**

$n$	$w_0$	m	$G_c$	Sc	Sigma	Phi	Time	$\tau_x$	$\tau_y$
0	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1732	0.02
0.5	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1689	0.0155
1	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1652	0.0123
0.7	0	1.5	0.4	1.1	2	0.5	0.35	-0.1674	0.0141
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1673	0.0141

0.7	1	1.5	0.4	1.1	2	0.5	0.35	-0.1653	0.0138
0.7	0.5	1	0.4	1.1	2	0.5	0.35	-0.176	0.0127
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1676	0.0141
0.7	0.5	2	0.4	1.1	2	0.5	0.35	-0.1609	0.0141
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1673	0.0141
0.7	0.5	1.5	1	1.1	2	0.5	0.35	-0.2932	0.0244
0.7	0.5	1.5	2	1.1	2	0.5	0.35	-0.503	0.0417
0.7	0.5	1.5	0.4	0.7	2	0.5	0.35	-0.1763	0.0155
0.7	0.5	1.5	0.4	0.9	2	0.5	0.35	-0.1715	0.0147
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1673	0.0141
0.7	0.5	1.5	0.4	1.1	0.5	0.5	0.35	-0.174	0.0749
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1673	0.0141
0.7	0.5	1.5	0.4	1.1	3.5	0.5	0.35	-0.1619	0.0135
0.7	0.5	1.5	0.4	1.1	2	0	0.35	-0.1363	0
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1673	0.0141
0.7	0.5	1.5	0.4	1.1	2	0.87	0.35	-0.2258	0.04
0.7	0.5	1.5	0.4	1.1	2	0.5	0.25	-0.1457	0.0097
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	-0.1673	0.0141
0.7	0.5	1.5	0.4	1.1	2	0.5	0.5	-0.1942	0.0204

From table 5.2, we observe that;

- i.) An increase in modified Grashof number  $Gc$  or an increase in Hall parameter  $m$  leads to a decrease in skin friction  $\tau_x$  and an increase in skin friction  $\tau_y$ .
- ii.) An increase in the mass diffusion parameter  $Sc$  leads to an increase in skin friction  $\tau_x$  but a decrease in skin friction  $\tau_y$ .
- iii.) A decrease in heat source parameter  $\sigma$  or an increase in time  $t$  causes a decrease in skin friction  $\tau_x$  and an increase in skin friction  $\tau_y$ . The removal of suction velocity  $w_0$  causes a decrease in skin friction  $\tau_x$  and an increase in skin friction  $\tau_y$ .

iv.) An increase in the angle of inclination  $\psi$  and ion-slip parameter  $n$  leads to a decrease in both skin frictions  $\tau_x$  and  $\tau_y$ .

**Table 5.3 Rate of Convection heat transfer Nu , Pr = 0.71 ,M<sup>2</sup>= 5.0, Gr = + 0.4**

$n$	$\omega_0$	$m$	Gc	Sc	Sigma	Phi	Time	Nu
0	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
0.5	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
1	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
0.7	0	1.5	0.4	1.1	2	0.5	0.35	2.4073
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
0.7	1	1.5	0.4	1.1	2	0.5	0.35	2.7002
0.7	0.5	1	0.4	1.1	2	0.5	0.35	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
0.7	0.5	2	0.4	1.1	2	0.5	0.35	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
0.7	0.5	1.5	1	1.1	2	0.5	0.35	2.5488
0.7	0.5	1.5	2	1.1	2	0.5	0.35	2.5488
0.7	0.5	1.5	0.4	0.7	2	0.5	0.35	2.5487
0.7	0.5	1.5	0.4	0.9	2	0.5	0.35	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
0.7	0.5	1.5	0.4	1.1	0.5	0.5	0.35	2.2977
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
0.7	0.5	1.5	0.4	1.1	3.5	0.5	0.35	2.769
0.7	0.5	1.5	0.4	1.1	2	0	0.35	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.87	0.35	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.25	2.5636
0.7	0.5	1.5	0.4	1.1	2	0.5	0.35	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.5	2.5425

From table 5.3, we observe that;

- i.) An increase in the mass diffusion parameter  $Sc$  and removal of suction velocity  $w_0$  causes an increase in the rate of heat transfer  $Nu$
- ii.) An increase in the angle of inclination  $\psi$  and modified Grashof number  $Gc$  leads to a decrease in the rate of heat transfer  $Nu$
- iii.) An increase in Hall parameter  $m$  and Ion-slip parameter  $n$  leads to a decrease in heat transfer  $Nu$
- iv.) A decrease in heat source parameter  $\sigma$  or increase in time  $t$  causes an increase in heat transfer  $Nu$

**Table 5.4 Values of skin friction  $\tau_x$  and  $\tau_y$  for  $Pr = 0.71, M^2 = 5.0, Gr = -0.4$**

$n$	$w_0$	$m$	$Gc$	$Sc$	$Sigma$	$Phi$	$Time$	$\tau_x$	$\tau_y$
0	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.00021885	0.00047523
0.5	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.00042832	-0.00035099
1	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.0005871	-0.00026745
0.7	0	1.5	0.4	1.1	2	0.5	0.4	-0.0027	-0.00004362
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.0004971	-0.0003137
0.7	1	1.5	0.4	1.1	2	0.5	0.4	0.0019	-0.00059513
0.7	0.5	1	0.4	1.1	2	0.5	0.4	-0.00017589	-0.00029941
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.0004971	-0.0003137
0.7	0.5	2	0.4	1.1	2	0.5	0.4	-0.00071975	-0.0003009
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.0004971	-0.0003137
0.7	0.5	1.5	1	1.1	2	0.5	0.4	-0.1264	0.01
0.7	0.5	1.5	2	1.1	2	0.5	0.4	-0.336	0.0272
0.7	0.5	1.5	0.4	0.7	2	0.5	0.4	-0.0095	0.0011
0.7	0.5	1.5	0.4	0.9	2	0.5	0.4	-0.0047	0.00033749
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.0004971	-0.0003137
0.7	0.5	1.5	0.4	1.1	0.5	0.5	0.4	0.0062	-0.0011
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.0004971	-0.0003137

0.7	0.5	1.5	0.4	1.1	3.5	0.5	0.4	-0.0059	0.00033006
0.7	0.5	1.5	0.4	1.1	2	0	0.4	-0.0014	0
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.0004971	-0.0003137
0.7	0.5	1.5	0.4	1.1	2	0.9	0.4	0.0026	-0.0014
0.7	0.5	1.5	0.4	1.1	2	0.5	0.3	0.014	-0.00041904
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	-0.0004971	-0.0003137
0.7	0.5	1.5	0.4	1.1	2	0.5	0.5	-0.0036	0.000081399

From Table 5.4, we observe that;

- i.) An increase in Modified Grashof number  $G_c$  and an increase in Hall parameter  $m$  leads to a decrease in skin friction  $\tau_x$  and an increase in skin friction  $\tau_y$ .
- ii.) An increase in the angle of inclination  $\psi$  and Ion-slip parameter  $n$  leads to a slight decrease in the skin friction  $\tau_x$  but an increase in the skin friction  $\tau_y$ .
- iii.) An increase in the mass diffusion parameter  $Sc$  leads to an increase in skin friction  $\tau_x$  but a decrease in skin friction  $\tau_y$ .
- iv.) A decrease in heat source parameter  $\sigma$  removal of suction velocity  $w_0$  and increase in time  $t$  cause a decrease in skin friction  $\tau_x$  and an increase in skin friction  $\tau_y$ .

**Table 5.5 Rate of convection heat transfer  $Nu$ , for  $Pr = 0.71, M^2 = 5.0, Gr = -0.4$**

$n$	$w_0$	$m$	$G_c$	$Sc$	$Sigma$	$Phi$	$Time$	$Nu$
0	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488
0.5	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488
1	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488
0.7	0	1.5	0.4	1.1	2	0.5	0.4	2.4073
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488
0.7	1	1.5	0.4	1.1	2	0.5	0.4	2.7002
0.7	0.5	1	0.4	1.1	2	0.5	0.4	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488

0.7	0.5	2	0.4	1.1	2	0.5	0.4	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488
0.7	0.5	1.5	1	1.1	2	0.5	0.4	2.548
0.7	0.5	1.5	2	1.1	2	0.5	0.4	2.5433
0.7	0.5	1.5	0.4	0.7	2	0.5	0.4	2.5487
0.7	0.5	1.5	0.4	0.9	2	0.5	0.4	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488
0.7	0.5	1.5	0.4	1.1	0.5	0.5	0.4	2.2977
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488
0.7	0.5	1.5	0.4	1.1	3.5	0.5	0.4	2.769
0.7	0.5	1.5	0.4	1.1	2	0	0.4	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.9	0.4	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.3	2.5636
0.7	0.5	1.5	0.4	1.1	2	0.5	0.4	2.5488
0.7	0.5	1.5	0.4	1.1	2	0.5	0.5	2.5425

From table 5.5, we observe that;

- i.) An increase in the modified Grashof number  $G_c$  and time  $t$  leads to a decrease in rate of heat transfer  $Nu$
- ii.) An increase in the mass diffusion parameter  $Sc$ , heat source parameter  $\sigma$  and removal of suction velocity  $w_0$  leads to an increase in the rate of heat transfer  $Nu$
- iii.) An increase in Hall parameter  $m$ , Ion-slip parameter  $n$  and angle of inclination  $\psi$  has no effect in the rate of heat transfer  $Nu$

### Conclusion

An analysis of the effects of various parameters on the velocities, temperature and concentration profiles on unsteady, free convection incompressible fluid flow past a semi- infinite vertical porous plate subjected to strong magnetic field inclined at an angle  $\psi$  to the plate with hall and ion-slip currents effects has been carried out. In all the considered cases, the applied magnetic field was resolved into two components and our work was restricted to the turbulent boundary layer.

In both cases of  $Gr > 0$  and  $Gr < 0$  it is observed that a thin boundary layer is formed near the stationary plate. The thickness of these boundary layers increases with increases in either Hall parameter  $m$  or ion-slip parameter.

. It was observed that in the absence of mass transfer and cooling or heating of the plate by free convection currents, increases in the Hall parameter  $m$ , the mass diffusion  $Sc$ , angle of inclination  $\psi$ , removal of suction velocity  $w_0$  leads to no effect in temperature. An increase in heat source parameter  $\sigma$  leads to a decrease in primary velocity profiles but to an increase in temperature profiles and secondary velocity profiles. For both  $Gr > 0$  and  $Gr < 0$  increases in the Hall parameter  $m$ , mass diffusion parameter  $Sc$  and removal of suction velocity  $w_0$  leads to decrease in primary velocity profiles.

For  $Gr > 0$  increases in Hall parameter, angle of inclination, time and modified Grashof number leads to a decrease in secondary velocity profiles. Whereas increase in mass diffusion parameter  $Sc$ , heat source parameter and removal of suction velocity leads to an increase in secondary velocity profiles.

For  $Gr < 0$  increase in mass diffusion parameter  $Sc$  and the removal of suction velocity leads to an increase in secondary velocity profiles but a decrease in primary velocity and concentration profiles. Increase in heat source parameter  $\sigma$ , angle of inclination, time and modified Grashof number  $Gc$  leads to an increase in primary velocity profile but a decrease in secondary velocity.

It was observed that an increase in the angle of inclination  $\psi$  or ion-slip parameter  $n$  causes an increase in primary velocity profiles and a decrease in secondary velocity profiles in both cooling and heating of the plate by free convection currents. Increases in Hall parameter leads to decrease in both primary and secondary velocity profiles. We also observed that increases in time leads to increase in both temperature and concentration profiles, but increase in heat source parameter, angle of inclination and removal of suction velocity causes decrease in temperature profiles.

Further, it is seen that the shear stresses increase due to the primary and secondary flows at the stationary plate with increase in Hall current parameter for fixed value of  $M^2$ , shear stress due to primary velocity  $\tau_x$  decreases while shear stress due to secondary velocity  $\tau_y$  increases with increase in ion-slip parameter  $n$ .

Increases in modified Grashof number  $Gc$  leads to an increase in velocity profiles near the plate but away from the plate the velocity profiles decrease in the presence of mass transfer and

cooling or heating of the plate by free convection currents. It was observed that an increase in the angle of inclination  $\psi$  leads to a decrease in both skin friction  $\tau_x$  due to primary velocity profiles and  $\tau_y$  due to secondary velocity profiles for  $Gr > 0$  and  $Gr < 0$ . It was observed that increases in Hall parameter  $m$ , modified Grashof number  $Gc$ , the removal of suction velocity  $w_0$ , or a decrease in heat source parameter  $\sigma$  leads to a decrease in  $\tau_x$  due to primary velocity profiles and an increase in  $\tau_y$  due to secondary velocity profiles for  $Gr > 0$  and  $Gr < 0$ . An increase in ion-slip parameter  $n$  leads to a decrease in  $\tau_x$  due to primary velocity profiles and  $\tau_y$  due to secondary velocity profiles, for  $Gr > 0$  but a decrease in  $\tau_x$  due to primary velocity profiles and an increase in  $\tau_y$  due to secondary velocity profiles for  $Gr < 0$ . Finally, increase in the angle of inclination  $\psi$ , ion-slip parameter  $n$ , Hall parameter  $m$ , modified Grashof number  $Gc$  and decrease in heat source parameter  $\sigma$  causes a decrease in the rate of convective heat transfer while increase in mass diffusion parameter  $Sc$ , time or removal of the suction velocity  $w_0$  leads to an increase in rate of convective heat transfer.

Generally the values of rate of heat transfer  $Nu$  for  $Gr > 0$  and  $Gr < 0$  were found to be approximately the same. This shows that cooling or heating of the plate by free convection currents has no effect on the rate of convection heat transfer at the plate.

We noted that if heat is supplied to the plate at a constant rate, then the flow field is affected. Due to the strong magnetic field, the presence of the hall current affected the flow significantly.

In the presence of hall current cooling of the plate by free convection current increases the thermal boundary layer.

In the power industry, among the methods of generating electric power is one in which electrical energy is extracted directly from a moving conducting fluid. This class of flow has many applications in the design of MHD generators, pumps and flow meters. In many cases the flow in these devices will be accompanied by heat either dissipated internally through viscous heating, joule heating or that produced by electric currents in the walls. We strongly recommend that the designers of these devices should take into consideration the effects of the parameters discussed in this study.

It is hoped that the results will be useful for applications including nuclear engineering especially in designing more efficient cooling system of nuclear reactors and that they can also be used for

comparison with other problems dealing with Hall current and ion-slip parameter which might be more complicated. It is also hoped that the results can serve as a compliment to other studies.

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## **Innovative Approaches for Climate Change Mitigation In Transport Institutions in Nigeria**

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### **ABSTRACT**

Accelerating the national and international innovative approaches for climate change mitigation is one of the key drivers for the achieving the objectives especially in developing countries like Nigeria where the policy implementation is becoming very difficult. Transport agencies reducing their greenhouse gas emissions are not in their self-interest because the domestic costs outweigh the domestic benefits according to their tradition. Several inter-governmental agencies are now incorporating innovative climate change mitigation such as managing transportation demand as much as possible by reducing the need to travel. This paper aims to review these programs with paired goals of assessing their success in promoting these innovation, and identifying newly formed innovation Instruments. The paper concludes that all programs reviewed have promoted the innovative approaches for climate change mitigation in transport agencies despite with incomplete implementation of these policies. The research has recommended that the international practices for innovative climate change mitigation approaches should be adopted in Nigeria in order to reduce incidents cause by climate change. Similarly, in future programs, part of the funding of the transport agencies should be dedicated to programs, doing research for new innovative approaches for climate change mitigation in transport agencies and development as well.

### **INTRODUCTION**

Transport infrastructure is one of the pillars of economic development of society and at the same time the largest contributor to greenhouse gases (GHG) emission that largely driven by the road and air transport. Global transport-related GHG emissions are expected to double by 2050 (Organisation for Economic Cooperation and Development, 2012). Transportation is significant to any nation economy, it quality of life and at the same time responsible for the greenhouse gases (GHG) emissions that are warming our planet. Scientists warn that global emissions cause by human activities must be adjusted in order to prevent it consequences within timeframe of decade or we face the consequences especially the developing countries where the

large majority of population of the world lives and where the susceptibility of this climate change impacts is extreme. The International Panel on Climate Change (IPCC) defines adaptation as the “adjustment in natural or human systems to a new or changing environment”. Whereas The International Panel on Climate Change (IPCC) defines mitigation as: “An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.” In 2007, scientists from the International Panel on Climate Change predicted the warming of oceans and melting glaciers or ices can create the rise of sea level up to 5 meters by the year 2100. Transportation activities are responsible for up to 23% of world energy-related greenhouse gas (GHG) emissions. Besides this, the transport sector is the second largest and second fastest growing source of global GHG emissions (Renukappa, 2013). Global transport-related greenhouse gases emission (GHG) are expected to double by 2050 if no new innovations and policies has being put in place (Organisation for Economic Cooperation and Development, 2012). Evidence from scientists has confirm and claim that climate change presents serious global risks for various sector of endeavor such as water resources, food security, biodiversity, human settlement, health, living conditions, and international peace and security. Therefore, climate change demands a serious global attention and coordinated response on multiple levels (Renukappa, 2013).

Paris Climate Conference held in December 2015, countries of more than 160 submitted their Intended Nationally Determined Contributions (INDCs) as their plan to decrease greenhouse gas (GHG) emissions and increase resilience. 140 countries INDCs identify transport as an important source of GHG emissions and area where action is needed. 23 countries INDCs identify their target on transport GHG emission decline and 105 nation states INDCs define their mitigation actions (Löhr, Perera, Hill, Bongardt and Eichhorst, 2017)

There are different innovations used in reducing the greenhouse gas emission in transportation by various countries in the world. Transportation sector is really a major GHG emission contributor that has a lot of discussion but how to de-carbonise the sector are still not defined (Löhr, Perera, Hill, Bongardt and Eichhorst, 2017). United State of America prospect to cut it GHG emissions from the transportation sector in cost-effective and more efficient up to 65 percent below 2010 levels by 2050 is through the improvement of vehicle efficiency, shifting to less carbon intensive fuels, travel behavior change, and operating as well (Greene, Baker Jr, Steven and Plotkin, 2011). Climate models suggest that Africa’s climate will generally become more variable, with high levels of uncertainty regarding climate projections in the Africa Sahel zone. Temperatures in West

Africa, and particularly the Sahel, have increased more sharply than the global trend (Federal Ministry of Environment, 2010).

For Nigeria, a recent study by Department for Food and International Development (DFID) (2009) predicts a possible sea level rise from 1990 levels to 0.3 m by 2020 and 1m by 2050, and rise in temperature of up to 3.2°C by 2050 under a high climate change scenario. This is based on IPCC climate change assumptions, latest research findings and results of a consultation exercise in Nigeria. The low estimate predictions are for sea level rise of 0.1 m and 0.2 m by 2020 and 2050 respectively, and a temperature increase of 0.4 to 1°C over the same time periods (Federal Ministry of Environment, 2010).

This paper has focused on the innovation used in Nigeria for mitigation of climate change causes by transport, their impact to climate change mitigation and the need to adopt new climate change mitigation practicing internationally in order to achieve our goals at national and international level. In Nigeria, The Federal Government's economic growth plan of Nigeria as of Vision 20:2020, Economic Transformation Blueprint (2009), has identifies the climate change as a threat to sustainable growth in the next decade. The federal government of Nigeria recognized climate change as a critical challenge to the world and, in Nigeria, as a potential driver of "damaging and irrecoverable effects on infrastructure, food production and water supplies, in addition to precipitating natural resource conflicts." This recognition is an important first step towards a climate change adaptation strategy and action plan in transformation Agenda 2011 – 2015. The agenda adapts the full priority policies and programs to suite into projects, purposely to ensure continuity, consistency and commitment of national development determinations. It identified 1613 projects across from 20 Ministries; however, the policy and implementation framework did not adequately address issues of climate change. In order to reveal the increasing importance of climate change issues in Nigeria, the Federal Executive Council in 2012 adopted the Climate Change Policy Response and Strategy. To ensure an effective national response to the significant and multi-faceted impacts of climate change, Nigeria has accepted a broadplan, as well as a number of specific policies such as low carbon to obtain certain objectives. The Nigeria objective is to contribute by taking action to adapt climate change in reducing its impact intensity, increasing the resilience, sustainable wellbeing of all Nigerians, minimizing risks by adaptive capacity improvement, leveraging new opportunities, and facilitating collaboration inside Nigeria and global community as well(Pew Research Center spring, 2015)

## **LITERATURE**

Climate change is among of the greatest challenges that our planet is facing in the future. Transportation is a major contributor to greenhouse gas (GHG) emissions that result to global warming. About one-third of the province's total GHG emissions in Ontario are coming from the transport activities and more than 80% originating from road-based transportation. Combating climate change impact will require less carbon-rigorous forms from transportation and initiate strategies that will reduce the need to travel (Ministry of Transportation Ontario's, 2009). Transportation is essential to nation development, which provides access to goods and services, social and economic benefits but if not properly managed, it lead to the extent of severe environmental, social and economic damage. UNDESA has conducted a researched which predicted that the world population will reach 9 billion by 2075 and most people will live in cities by 2025. So far this is already the case in industrialized nations; with rapid changes in developing countries that will need assistance to shift toward more sustainable development direction. Health concerns and down fall of living conditions caused by traffic congestion and pollution has become necessary to invite for more efficient, economical, socially acceptable and environmentally viable transport structures and defining limits to fossil fuel resource use for climate change (Commission on Sustainable Development 9 and 18, 2000 and 2010)

Innovation and technology will be an essential in provide responses to climate change, energy security and economic growth. The solutions are achievable, affordable and realistic but will require full determination work and international cooperation to be successfully implemented. To achieve this, we must have a double foresight immediately to apply the available decision in order to minimize this global emission by the year 2020 and spend in the technologies of the future in order to build the capacity to make long-term cuts decision. Copenhagen is the moment for the world to signal this commitment and clearly signpost the path to a sustainable future (The Climate Group, 2009).

In the context of the work of the Commission on Sustainable Development, the transport theme was included in Agenda 21 and the Johannesburg Plan of Implementation as a result of the World Summit in Rio de Janeiro in 1992 and since then part of intergovernmental discussions, among others highlighted in climate smart department (CSD 9) in the year 2000 and (CSD18) in 2010. Transport will also be part of the negotiations at the CSD in 19 May 2011 and an important theme

in the United Nation Climate Smart Department (UNCSD) in 2012. In order to keep the global temperature increase below 2 degrees Celsius, as recommended in the Copenhagen Accord, industrialized countries will need to reduce emissions up to 25-40% below 1990 levels by 2020. With regards to developing nations, they would need to reduce GHG emissions of 15-30% below Business as Usual (BAU) by 2020. For the transport sector alone this would turn to 0.6-1.3 GtCO<sub>2</sub>-eq/yr reduction by 2020. This will require determined and coordinated action on the side of developing countries with combines domestic action and internationally support actions through: (a) traditional development, including the multilateral development banks (MDBs), (b) special climate funds like Global Environmental Facility (GEF) and Clean Technology Fund (CTF), as well as (c) dedicated climate mechanisms in the form of Clean Development Mechanism (CDM) and Nationally Appropriate Mitigation Actions (NAMAs)(Commission on Sustainable Development 9 and 18, 2000 and 2010).

Emission from air transportation is expected to increase with income growth in developing countries and an emission from shipping is expected to grow by 150-250% compared to emission levels in 2007. According to the International Energy Agency, transport accounts for 13% of all global GHG emissions and 23% of global carbon dioxide emissions. Transport energy consumption increased by 37% between 1990 and 2005 while carbon dioxide emissions from transport anticipated increasing by 57% between 2005 and 2030. Road transport alone accounted 89% of energy use attributed to transport in 2005, and grew by 41% between 1990 and 2005, compared to 13% growth in emissions related with non-road modes of transport. Almost 60% of total global road transport emissions originate from North America and Western Europe. China ranks third in transport related energy consumption and emissions behind the USA and Europe, and tripled its consumption of transport related energy between 1990 and 2005(United Nations Environment Programme,Green Economic Review, 2011)

The Kyoto Protocol (KP) is a treaty between industrialised and non-industrialised nations that was discussed in Kyoto, December 1997in Japan under the United Nations Framework Convention on Climate Change (UNFCCC). The treaty was then opened for signing in 1998, closed in 1999, and became active later in February 2005. Under this treaty, industrialised countries are required to reduce their greenhouse gas emissions by 5.2% compared to 1990 levels of emissions but the agreement has not been endorsed by the USA and a few other leading industrialised nations. Nevertheless, the targets for the European Union are set at 8%, the US 7%,

Japan 6% and Russia 0%, while increases of 8% has been permitted for Australia and 10% for Iceland. The introduction of the carbon economy has profound implications for competitiveness of cities. The direct implications are that cleaner production. The post-Kyoto discourse on climate change and the need to reduce GHG emissions has taken many twists and turns. At first, the science behind climate change projections was subject to serious inspection by governments which were unwilling to contemplate the large changes that would be required to offset the progression of global climate change effects. The recent United Nations Framework Convention on Climate Change (UNFCCC) in Copenhagen in 2009 failed to ensure that a legally binding deal was signed. Prior to Copenhagen 2009, the Bali Climate Convention in 2007 agreed that negotiations would occur on two tracks with working groups dealing with long-term cooperative action (LCA) and the Kyoto Protocol (United Nations Environment Programme, Green Economic Review, 2011)

The LCA working group was concerned with negotiations on long-term reduction targets for developed countries and on the role and potential of developing countries to engage in mitigation and adaptation activities through technology transfer and support from developed countries. The KP working group was concerned with deeper emission cut targets for developed countries, potential amendments to KP, and the role of Clean Development Mechanisms (CDM), land use change, forestry etc. in reducing emissions. Both LCA and KP negotiations should have been concluded by the end of Copenhagen 2009. Perhaps the most significant development at Copenhagen was that the accord recognizes – for the first time – the need to restrict global warming below 2 degrees Celsius. Yet no binding agreement was obtained, and while a 25-40% reduction in GHGs is required of rich countries according to the IPCC. World Resource Institute study indicates that commitments by rich countries range between 13-19% (United Nations Environment Programme, Green Economic Review, 2011)

Paris Climate Conference held in December 2015, countries of more than 160 submitted their Intended Nationally Determined Contributions (INDCs) as their plan to decrease greenhouse gas (GHG) emissions and increase resilience. 140 countries INDCs identify transport as an important source of GHG emissions and area where action is needed. 23 countries INDCs identify their target on transport GHG emission decline and 105 nation states INDCs define their mitigation actions. A high level analysis of the NDC documents carried out by GIZ showed that transport has been recognized as one sector of key relevance for climate change. Due to the imperfect level

of information provided in the official NDC documents, more analysis at the country level is needed to be able to assess the role of transport in the INDC development and implementation process. To gain such insight for the transport sector in rapidly-motorising countries, seven case studies were carried out in the following countries namely: Bangladesh, Colombia, Georgia, Kenya, Nigeria, Peru and Vietnam. Data for the analysis was gathered through literature investigation and stakeholder interviews and complemented by experiences from GIZ's and Ricardo's day-to-day work in countries. Some of the lessons learnt from these countries are (Löhr, Perera, Hill, Bongardt and Eichhorst 2017):

- Lack of transport data limits the sectorial ambition.
- Not in cooperating key transport actors is essential for ambitious sector targets.
- NDC should be more closely associated with transport sector strategies.
- Transport authorities need more climate change expertise.

There are different innovations used in reducing the greenhouse gas emission in transportation by various countries in the world. Transportation sector is really a major GHG emission contributor that has a lot of discussion but how to de-carbonise the sector are still not defined (Löhr, Perera, Hill, Bongardt and Eichhorst, 2017).

The scientific evidence is clear that human activity is causing the global climate to change and this activities will still persist that will cause more extreme changes. The need to begin reducing emissions of CO<sub>2</sub> and other GHGs from all human activities sources in transportation sector is supported by many independent scientific sources. The 2010 America's Climate Choices report by the U.S. National Academy of Sciences (NAS, 2010) makes it clear that the earth's climate is changing and majority of these changes are due to human activity. The NAS concludes that climate change is occurring, caused largely by human activities which cause threat generally to human and natural systems" (NAS, 2010). A report by the U.S. Environmental Protection Agency (EPA) in 2010 identified a number of climate change indicators already evident today. For example, sea surface temperatures have been warming in the last three decades than any other time since large-scale measurement began in the late 1800s, and Arctic sea ice in 2009 was 24 percent below the 1979 to 2000 historical average. In the United States, seven of the top 10 warmest years on record for the lower 48 states have occurred since 1990 (EPA, 2010e). To mitigate future climate impacts, curbing GHG emissions from all sectors including the transportation sector must begin now (Greene, et.al, 2011).

Transportation will have to severely reduce its GHG emissions by 2050 to mitigate the effects of climate change. The three scenarios show different combinations of policies, technologies and behavior could reduce transportation's CO<sub>2</sub> emissions by anywhere from 15 to 65 percent below 2010 levels by 2050. However, at present, it is not possible to conclude with confidence precisely how great a reduction in transportation sector could happen by 2050 (Greene, et.al, 2011).

Reducing GHG emissions from all sectors must begin now in order to minimize climate impacts. While the role of GHGs in changing global climate is well established, there are disagreements about what might constitute unacceptable damage and a range of projected temperature changes and resulting impacts. Many governments in developed countries have called for GHG emissions to be cut by up to 80 percent by 2050 in order to stabilize atmospheric concentrations of GHG. Transportation accounts about fifth of global GHG emissions, reducing emissions from this sector must be a key part of a global strategy to combat climate change (Greene, et.al, 2011).

Vehicle ownership in Nigeria is currently low by international standards, standing at approximately 29 cars per 1,000 people as of 2010. However, ambition for car ownership is high due to the status of increasing income levels expected to bring Nigeria into line with other countries based on expected per capita income levels. The combined impact of population growth and growing car ownership is expected to increase the private car fleet in Nigeria from 4.65 million to over 20 million over the forecast period. However, growth in public transport and commercial vehicle numbers and activity is expected to be even more pronounced. Passengers traveling by public transport are typically served by para-transit, minibuses etc. These vehicles are usually privately owned and operated to serve the interests of the owner/operator, with intense competition among drivers. GHG emissions are forecast to increase significantly in Nigeria over the forecast period, driven by increasing population, economic activity, and wealth, reaching over 187 Mt by 2035. So far, Nigeria has no stated CO<sub>2</sub> emissions standards for cars. The current average emissions level across the Nigerian private car fleet is estimated to be 214g CO<sub>2</sub>/km. This is clearly far behind the standards being adopted in Europe. To put this into context, by 2035, emissions levels in Nigeria are likely far to exceed the level currently generated by the road transport sector across Sub-Saharan Africa as a whole (133 Mt in 2008) (Federal Government Gazette, 2011). In order to reflect the increasing importance of climate change issues in Nigeria, the Federal Executive Council adopted in 2012 the Nigeria Climate Change Policy Response and Strategy. To ensure an effective national response to the significant and multi-faceted impacts of

climate change, Nigeria has adopted a comprehensive strategy, as well as a number of specific policies. The strategic goal of the Nigeria Climate Change Policy Response and Strategy is to foster low-carbon, high growth economic development and build a climate resilient society through the attainment of the following objectives (Federal Government Gazette, 2011):

- ✓ Implement mitigation measures that will promote low carbon as well as sustainable and high economic growth;
- ✓ Enhance national capacity to adapt to climate change;
- ✓ Raise climate change related science, technology and to a new level that will enable the country to better participate in international scientific and technological cooperation on climate change;
- ✓ Significantly increase public awareness and involve private sector participation in addressing the challenges of climate change;
- ✓ Strengthen national institutions and mechanisms (policy, legislative and economic) to establish a suitable and functional framework for climate change governance.

The country Nigeria is considerably impacted by climate change. The north of the country, for example, is highly vulnerable to drought. A recent Bench Research Center global attitudes survey found that 65% of Nigerians are very concerned about the threat climate change poses, ahead of global economic instability (48%). HE President Buhari has stated in his inaugural speech that Nigeria is committed to tackling climate change. Nigeria's intended nationally determined contribution (INDC) demonstrates its determination to contribute to the success of the Paris climate summit in December 2015 and to grow its economy sustainably while reducing carbon pollution. The INDC promotes sustainable development and delivering on government priorities. The policies and measures included in the Nigeria INDC will deliver immediate development benefits and do not compromise sustainable growth, on the contrary. Ambitious mitigation action is economically efficient and socially desirable for Nigeria, even when leaving aside its climate benefits. The policies and measures alleviate poverty, increase social welfare and inclusion, as well as improving individual well-being, which includes a healthy environment. Furthermore, by not undertaking these measures, Nigeria would incur significant adaptation costs from intensified climate change. Nigeria has been actively engaged in international climate policy negotiations since it became a Party to the UN Framework Convention on Climate Change (FCCC) in 1994 ratifying its Kyoto Protocol in 2004. Nigeria submitted its First National Communication (FNC)

in 2003 and a Second National Communication in February 2014. Nigeria is host to a number of Clean Development Mechanism projects, as well as projects financed by the Adaptation Fund. In September 2012, the Federal Executive Council approved the Nigeria Climate Change Policy Response and Strategy. HE, President MuhammaduBuhari, The President of the Federal Republic of Nigeria on 26 November 2015, approved the Nigeria INDC(Pew Research Center spring, 2015)

### **Nigeria institutional framework**

Nigeria has created a Special Climate Change Unit (SCCU) within the Federal Ministry of Environment with the Secretariat in Abuja, Nigeria. The Unit is created to implement the Convention and the protocol activities. The SCC Unit also has responsibility of coordinating the activities of the Inter-ministerial Committee on Climate Change with representation from various; Finance, Agriculture, water Resources, Energy Commission, Nigeria National Petroleum Corporation (NNPC), Foreign Affairs, Nigerian Meteorological Agency (NIMET), industry, NGOs (Nigerian Environmental Study/Action Team), and Academic (Centre for Climate Change and Fresh Water Resources, Federal University of Technology Minna; Centre for Energy , Research and Development, ObafemiAwolowo University Ile-Ife; and AbubakarTafawaBalewa University, Bauchi. There is also a Presidential Implementation Committee on the Clean Development Mechanism (CDM) in the Presidency. With regards to improving the national capacity to create observational climate data and climate monitoring systems, government upgraded the Department of Meteorology in the Ministry of Civil Aviation to a full-fledged Nigerian Meteorological Agency (NIMET) in 2003, which now has a Climate Research Unit for data generation and climatic information dissemination(Federal Ministry of Environment, 2010)

With regards to the political system of theNigeria, the Senate has a standing committee on ecology (Senate Committee on Ecology) while the National House of Assembly has a standing Committee on Climate Change. Members of these Committees have facilitated the passing of a Climate Change Commission (CCC) Bill in both the House and Senate level. However, there is still no timeframe as to the time the CCC will take off. In addition to the Committees, there is a National Council on the Environment, made up of representatives of governments at the Federal and State levels. The Council meets at irregular intervals to discuss the state of the environment in Nigeria (Federal Ministry of Environment, 2010)

### **CLIMATE CHANGE ADAPTATION IN NIGERIA**

The summary of impacts above shows Nigeria to be highly vulnerable to climate change. The 2014 World Climate Change Vulnerability Index, published by the global risk analytics company VeriskMaplecroft, classifies Nigeria as one of the ten most vulnerable countries in the world. A recent government study determined vulnerability across Nigeria's geographical regions, focusing on the three principal determinants of vulnerability: adaptive capacity, sensitivity and exposure. The relative vulnerability of the six geopolitical zones of Nigeria is shown below. There is a general south-north divide. The three northern zones show higher vulnerability than those in the south. This reflects the higher rainfall and socio-economic development of the south. The south-south shows highest relative variability among the three southern zones, reflecting the challenges of coastal flooding and erosion, as well as the impact of petroleum exploration and exploitation in that part of the country. The southwest is least vulnerable, the northeast, on the other hand, is most vulnerable. Understanding these spatial vulnerabilities is crucial to shaping climate-resilient development in Nigeria. Euro II standards (FGG 2011) were adopted at the end of 2011 for all new and imported vehicles. The import of two-stroke motorcycles was banned although import of large numbers of these high-polluting three-wheelers prior to the ban means that they are wide- spread in many parts of the country. The existing vehicle fleet is made up of aging, high- polluting vehicles, majority imported from western countries only when they approach the end of their economic life. Cars up to 8 years old can be imported, trucks younger than 15 years can be imported and buses less than 10 years old as well(Pew Research Center spring, 2015)

#### **BUSINESS AS USUAL EMISSIONS PROJECTIONS IN NIGERIA**

Nigeria's economy and population are both growing rapidly, and the population is attaining a higher standard of living. This growth will have a strong impact on future emissions. Following careful review of the re-based GDP data for 2010-2014 and official population projections the "business-as-usual scenario" was developed as part of the preparation of this INDC. This scenario assumes an economic growth at 5%, population growing at about 2.5% per year, all Nigerians to have access to electricity (both on-grid and off-grid) and demand is met, industry triples its size by 2030. Under this scenario, emissions are projected to grow 114% by 2030 to around 900 million tons around 3.4 tons for every Nigerian. Under a high growth scenario, with economic growth at 7%, this rises to over one billion tons(Pew Research Center spring, 2015)

#### **MITIGATION POTENTIAL ASSESSMENT OF GHG EMISSION IN NIGERIA**

The mitigation assessment in Nigeria could be difficult at the moment because the Nigeria is at the phase1 of the INDC. The mitigation actions, which could be undertaken, were assessed in a bottom up manner, building on expert assessments of both the challenges facing individual sectors, as well as a review of policies and measures already in place. The measures included in Nigeria's INDC are expected to deliver significant development benefits. The mitigation actions that bring the largest development benefit are reducing air pollution, indoors and outdoors, with enormous immediate health and social benefits. Secondly, innovation in "clean" technologies brings resource efficiency and produces more knowledge and jobs than those in "dirty" technologies. Thirdly, fiscal reform is proving an efficient mitigation action. This releases significant resources in the budget that can fund investments in efficient infrastructure and other fiscal policies, thus creating jobs and fuelling growth. Beyond mitigation actions that could be quantified, several qualitative policies and measures have been identified(Pew Research Center spring, 2015).

#### **UNCONDITIONAL CONTRIBUTION OF GHG MITIGATION IN NIGERIA**

In the event an ambitious, comprehensive legally binding global agreement is reached at Paris convention on climate change, Nigeria will make an unconditional contribution of 20 per cent below BAU that is consistent with the current development trends and government policy priorities. The policies and measures that will deliver these savings are cost-effective, even at the current high interest rate, which constrains investment. They include improving energy efficiency by 20 percent, 13 GW of renewable electricity provided to rural communities currently off-grid, and ending gas broadening(Pew Research Center spring, 2015)

#### **CONDITIONAL CONTRIBUTION OF GHG MITIGATION IN NIGERIA ON INTERNATIONAL SUPPORT**

Nigeria can make a significant additional contribution with international support, in the form of finance and investment, technology and capacity building. The combined policies and measures described below can deliver in a cost-effective manner direct development benefits to the country and reduce emissions 45 per cent below BAU. The key measures are an increased level of energy efficiency and a significant reduction in the use of generators, while providing access to energy for all Nigerians(Pew Research Center spring, 2015).

**Table 1: Summary of key aspects of Nigeria's INDC**

Aspect	Detail
Type of objective	Reduction from Business as Usual (BAU)
Target year	2030
Implementation Period	2015-2030
Base data period	2010-2014
Summary of objective	Economic and social development: grow economy 5% per year, improve standard of living, electricity access for all
Unconditional and conditional mitigation objectives	20% unconditional, 45% conditional
Key measures	<ul style="list-style-type: none"> <li>• Work towards ending gas flaring by 2030</li> <li>• Work towards Off-grid solar PV of 13GW (13,000MW)</li> <li>• Efficient gas generators</li> <li>• 2% per year energy efficiency (30% by 2030)</li> <li>• Transport shift car to bus</li> <li>• Improve electricity grid</li> <li>• Climate smart agriculture and reforestation</li> </ul>
Trajectory [update figure once agreed]	
Emissions per US\$ (real) GDP	0.873 kg CO <sub>2</sub> e (2015) [0.491 kg CO <sub>2</sub> e (2030)]
GDP per capita (US\$)	2,950 (2014) 3,964 (2030; real 2015 US\$)

Source: Nigeria's INDC

### SHORT-TERM GHG EMISSION MITIGATION IN NIGERIA

Introduced regulation related to engine technology, prohibiting the import of two-stroke motorcycles and adopting Euro 2 standards as a minimum for all vehicles imported or sold from the end of 2011 (FGG 2011) although import of large numbers of these high-polluting three-wheelers prior to the ban means that they are wide-spread in many parts of the country. The existing vehicle fleet is made up of aging, high-polluting vehicles, majority imported from western countries only when they approach the end of their economic life. Cars up to 8 years old can be imported, trucks younger than 15 years can also be imported and buses less than 10 years old as well (Pew Research Center spring, 2015).

**LONG-TERM GHG EMISSION MITIGATION IN NIGERIA**(Pew Research Center spring, 2015):

- Modal shift from air to high speed rail
- Moving freight to rail
- Upgrading roads
- Urban transit
- Toll roads/ road pricing
- Increasing use of Compressed Natural Gas (CNG)
- Reform petrol/ diesel subsidies

## **INTERNATIONAL POLICY AND IMPLEMENTATION ON GHG EMISSION MITIGATION ON TRANSPORT**

### **Business Planning**

Any organization that carries a business activities, operation or services must have principles and certain characteristics peculiar to it. Applying the principle of GHG emission mitigation as business priorities, funding requirements and performance measures will ensure that the desirable results and outcomes of the program will be achieve efficiently and cost effectively. Similarly, the implementation stages should go along with evaluation, reporting as feedback for the purpose of correcting any mistake in the policy or during the implementation periods (Ministry of Transportation Ontario's, 2009).

### **STANDARD AND PRACTICES**

Standardization in any aspect is very important especially in transportation system. Incorporating standard in designing, construction, operation and maintenance will seriously help in economy, social and environmentally. Pavement design standard make road construction more sustainable by maximizing the lifespan of the pavement reduces noise, use of raw material, reuse and recycle. These practices will assist in use less energy and less GHG emission (Ministry of Transportation Ontario's, 2009).

### **ENVIROMENTAL IMPACT ASSESSMENT**

Transportation infrastructure is one of the major contributors to climate change and therefore need environmental assessment in carrying any project. Transportation impacts are well-

understood and some can be predicted base on experience. Therefore, it will be steward to study any project that will be undertaken to pass all necessary consideration that may affect the environment and offer a proper recommendation (Ministry of Transportation Ontario's, 2009).

### **STAKEHOLDER/SHAREHOLDER**

Appropriate communication and involvement of Stakeholders' will adds considerable value to the program. The earlier they are involved, the better the result, involving the stakeholders are a powerful mover for change, while Ignoring them can lead to failure. Their involvement should include (British Standard Guideline, 2010):

- (a) Focus groups;
- (b) facilitated workshops;
- (c) Early prototyping;
- (d) Simulations.

### **EMPLOYEE EDUCATION AND AWARENESS:**

Employees are important tools that any organization use to initiate, implement any new programs. Therefore, it will be necessary to educate them the basic aspect of the GHG emission mitigation in a formal and informal approach. This can be obtaining through (Ministry of Transportation Ontario's, 2009):

- Developing workshop
- Lunch and learn
- Ride-sharing
- Provision of shuttle services

### **EMPLOYEE RECOGNITION**

Recognizing staff to incorporate sustainable business practices will help drastically in full awareness of the subject matter. There is need for celebrating any achievement or initiative contributes by any staff because this will encourage them to continue to find means to integrate GHG emission mitigation into their activities (Ministry of Transportation Ontario's, 2009).

### **LEGISLATION AND REGULATION**

Legislation and regulation is one of the parameters the planners used in trying to stabilize the transportation system. For instant, mandating the use of speed limiters in determining speed, prohibition of old age vehicles will all help in reduces GHG emissions, road safety and fuel

economy(Ministry of Transportation Ontario's, 2009).

### **INFRASTRUCTURE:**

The choices we plan in building infrastructure, how and where to build and how long to stay in operation has an impact to our GHG emission. Expansion of road to reduce congestion, protecting natural and agricultural land and asses the environmental impact before and after the project completion is vital (Ministry of Transportation Ontario's, 2009).

### **PUBLIC EDUCATION:**

GHG emission issues are all about changing of people behavior in respect to their daily activities for better living. There is need people to be educated on what are expected to change their behavior. Medium that is used to achieve this are (Ministry of Transportation Ontario's, 2009):

- ❖ Incorporating GHG emission in beginners' drivers education curriculum,
- ❖ Preparing and distributing books to schools,
- ❖ Educating people impact on climate change,
- ❖ Educating people on sustainable mode, available mode, travelling information as well as the implication of each,
- ❖ Organizing conferences for all sort of organization.

### **BENEFITS OF GHG EMISSION MITIGATION ON TRANSPORTATION (Raji, (2017) :**

- Shifting to green transportation would help clear the atmosphere of toxic gases since these modes of transportation have few to zero emissions.
- Saves you money by embracing green transportation modes like bicycles, multiple occupant cars, electric motorcycles, ride sharing etc.This will save you a lot from costs related to buying fossils fuels at the filling station.
- Manufacturing and distribution of green vehicles will go along with improving existing transport systems. This will lead to creation of more jobs in the transport sector, hence, minimizing social-economic disparities and building up a sustainable economy.
- Minimize over-reliance on fossil fuels, which drain an economy.
- Improved healthby producing green vehicles that are not harmful to human health, so embracing green transportation will only improve a country's health status.
- Reducing the cost of travel due to traffic congestion.

## **CHALLENGES OF GHG EMISSION MITIGATION ON TRANSPORTATION**

### **INCREASE IN POPULATION**

UNDESA has undertaken that the world population will reach 9 billion by the year 2075 and by 2025 most people will live in cities. This situation has already manifested itself in industrial countries and many developing countries are rapidly changing. Improper management of such increase in the population will lead to air pollution, shortage of transport infrastructure, deterioration of water quality and so forth (Ministry of Transportation Ontario's, 2009).

### **CONGESTION**

A reliable transportation network is essential giving access to goods and services to people. Transportation system is the most vital component of business logistic cost in economic activities. One third to two third of the expenses of enterprises logistic cost is spending on transport (Jeon, 2005). The biggest influence of population in transportation system is traffic congestion. Congestion cost losses in business to significant figure of money from £7b to £20b on different estimate. Therefore relieving congestion is good to economic, social and environmentally (Joseph, 2000).

### **CREATING GREEN ECONOMY/REACHING ZERO WASTE**

Transportation network is one of the key drivers in any society, hence we do not have chosen between environmental protection and a sound economy. New opportunities can occur from protecting the natural environment and reduces our GHG emission (Ministry of Transportation Ontario's, 2009).

### **METHODOLOGY**

The researcher has used secondary data to carry out this piece of research. Some of the reasons that lead to secondary data and not primary source, there is not much literature on the context of GHG emission even at the federal government of Nigeria level talk less on private sector in the country. Therefore, the researcher has used Intended Nationally Determined Contributions (INDCs) documents submitted by Federal Republic of Nigeria, International Panel on Climate Change (IPCC), UN Framework Convention on Climate Change (FCCC) in 1994 ratifying its Kyoto Protocol in 2004, U.S. National Academy of Sciences and other few journals on GHG emission mitigation in Nigeria. Nigeria is one of the African countries that are located in West

Africa which is the most populated country in the entire Africa, with about 155 million people in 2011, about one-sixth of the entire continent. The country is predicting to be among strongest 20 economic countries in the world and therefore call for GHG emission mitigation is equally important before the scenario of negative impact on climate change become out of control.

## **RESULTS AND DISCUSSION**

Transportation system is one of the organs of any developed or developing nation which cannot do without it. The functionality of any sector in the world will never be operated efficiently without good existence of transport. Movement of goods, services and companies rely on transportation activities to make their function are all part of transport family. Therefore, human being cannot adopt full live without transportation system and at the time transportation system is one of the major contributor of greenhouse gas emission that create a lot of negative impact in our planet. From what is happening today and base on experience, live is not complete without transportation system. Since we cannot escape from this sector, there is need to improve how transportation system carry out their day to day activities including other companies that rely their function on transport to reduces this greenhouse gas emission to our planet. There are a lot practices adopted in the world with the intention of mitigation the greenhouse gas emission in transportation activities to our planet such as improvement of technology, human behavior, changing of fuel technology among other.

Nigeria has been actively engaged in international climate policy negotiations since it became a Party to the UN Framework Convention on Climate Change (FCCC) in 1994 ratifying its Kyoto Protocol in 2004. Nigeria submitted its First National Communication (FNC) in 2003 and a Second National Communication in February 2014. Nigeria is host to a number of Clean Development Mechanism projects, as well as projects financed by the Adaptation Fund. In September 2012, the Federal Executive Council approved the Nigeria Climate Change Policy Response and Strategy. Recently, His Excellency, President MuhammaduBuhari, The President of the Federal Republic of Nigeria on 26 November 2015, approved the Nigeria INDC. According to the World Climate Change Vulnerability Index, published by the global risk analytics company VeriskMaplecroft in 2014, Nigeria has been classified as one of the ten most vulnerable countries in the world. Secondly, Nigeria's economy and population are both growing rapidly, and the population is attaining a higher standard of living. This growth will have a strong impact on future emissions.

A recent government study determined vulnerability across Nigeria's geographical regions, focusing on the three principal determinants of vulnerability. The relative vulnerability of the six geopolitical zones of Nigeria shows that the three northern zones illustrate higher vulnerability than those in the south. This reflects the higher rainfall and socio-economic development of the south. The south-south shows highest relative variability among the three southern zones, reflecting the challenges of coastal flooding and erosion, as well as the impact of petroleum exploration and exploitation in that part of the country. The southwest is least vulnerable, the northeast, on the other hand, is most vulnerable. Understanding these spatial vulnerabilities is crucial to shaping climate-resilient development in Nigeria. Therefore, Nigerian has understood and experienced the negative impact of GHG emission to our planet. The submission of Intended Nationally Determined Contributions (INDCs) by the Nigeria government is a positive movement in supporting the international community in trying to reduce or mitigates greenhouse gas emission to our planet. So far Nigeria is at the phase 1 of the INDC submitted documents that is not more preparation and planning of the implementation stage. Nevertheless, Nigeria government were able to introduced regulation as start and short term GHG emission mitigation related to engine technology, prohibiting the import of two-stroke motorcycles and adopting Euro 2 standards as a minimum for all vehicles imported or sold from the end of 2011 (FGG 2011) although import of large numbers of these high-polluting three-wheelers prior to the ban means that they are wide- spread in many parts of the country. The existing vehicle fleet is made up of aging, high- polluting vehicles, majority imported from western countries only when they approach the end of their economic life. Cars up to 8 years old can be imported, trucks younger than 15 years can also be imported and buses less than 10 years old as well. The assessment of mitigation measures start by Nigeria government is too early mention due to the lack of comprehensive data and measuring mechanism on GHG emission in the country. Therefore, the researcher looks as progress to Nigeria government and Nigerian citizens as well in term of GHG emission mitigation or control.

## **CONCLUSION**

Greenhouse gas emission has become a global issue which requires much attention and cooperation among the developed or industrialised nations and developing countries as well in order to reduce it impact in our planet. Nigeria has been actively engaged in international climate policy negotiations since it became a Party to the UN Framework Convention on Climate Change

(FCCC) in 1994 ratifying its Kyoto Protocol in 2004. Recently, His Excellency, President MuhammaduBuhari, The President of the Federal Republic of Nigeria on 26 November 2015, approved the Nigeria INDC documents submitted in the Paris climate summit in December 2015 as a support and participation on the international effort in trying to mitigate the negative impact on GHG emission as a result of the human activities and in particular on transport sector as a major contributor. This paper has found that the initiative of the Federal Republic of Nigeria on GHG emission mitigation on transportation sector can bring some changes as per as the phase 1 of the INDC documents is concern. It is too early and difficult to obtain reason data collected on GHG emission on transport that can be access on the implementation of the INDC official documents submitted by the Federal Republic of Nigeria.

Secondly, almost all the parameters used in determining the level or intensity of GHG emission by country or sectors are being aided and access by the international mechanism. Thirdly, there are still shortages of skills personals or experts on transportation sector in Nigeria that can give correct figures on the intensity or amount of GHG emission mitigation achieve based on the INDC documents submitted by Federal Republic of Nigeria. Lastly but not the least, according to the World Climate Change Vulnerability Index, published by the global risk analytics company VeriskMaplecroft in 2014 which Nigeria is involved, most of transport agencies staff are not involved in this GHG emission mitigation business. Nevertheless, Nigeria will achieve its goal on states, regions; national and international standards as far as these phases of INDC official documents submitted by Nigeria government in the Paris climate summit in December 2015 will be fully adopted and implemented.

#### RECOMMENDATION

According to the literature review on climate change mitigation in Nigeria and the researcher view, the following points must be adopted with respect to climate change mitigation in Nigeria to achieve the objectives:

- Nigeria government cannot fully implement the climate change mitigation as require by industrialised nations without the international funding aid.
- There is need for Nigeria government to provide its GHG emission level by the cars.
- There is need for the Nigeria government to provide the measuring mechanism that will provide precise data on the GHG emission emitted by transport.
- In cooperating key transport actors is essential for achieving the goals in transport sector.

- Special budget should be arranged for climate change mitigation in Nigeria
- Private sector participation and investment into climate change opportunities.
- Climate change mitigation is not an issue of single handle responsibility but need the involvement of 36 states and 774 local government areas in the country for the achievement of the goals.
- Transport authorities must be involved in GHG emission policies and planning for the success of the programmes.
- Nigeria need more transport expert on climate change mitigation for precise and available data.
- There is need for Nigeria government to adopt the international climate change mitigation practices around the world.

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## Effect of Streamflow on Hydro-Power Generation in the Upper Tana River Basin, Kenya

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### ABSTRACT

Hydro-power is one of the Kenya's important energy sources. The main hydro-power project in Kenya is located in the Upper Tana River basin. There has been a fluctuation of power generation due to climate change over the years. The main objective of this research was to assess the effect of streamflow on hydro-power generation under climate change scenarios. Hydro-power generation is estimated by relating the runoff changes to hydro-power generation through the ArcGIS software, in conjunction with ArcSWAT model based on 30-year hydrometric data. Results showed a peak discharge in May, with gradual decrease, the first decade registering a peak flow of 82.74 m<sup>3</sup>/s in Tana-Sagana River followed by 80.65 m<sup>3</sup>/s. The annual average dam inflows declined at the rate of 0.7992 m<sup>3</sup>/s annually. For the 30 years, dam inflow decreased by 23.98 m<sup>3</sup>/s. The minimum inflow rates increased with the years 2000 and 2009 having the lowest inflows of 21.4 m<sup>3</sup>/s and 22.8 m<sup>3</sup>/s respectively. The highest inflow and lowest inflow occurred in 1998 and 2009. A decreasing trend in the amount of hydro-power produced in the scheme from 1990 to 2010. The driest years, which were 1999-2000 and 2009, recorded the lowest levels of hydro-power generation. Decreasing amounts of precipitation and increasing temperatures have led to declining Masinga dam inflow rates. Results from this study are useful in explaining the trend in hydropower generation in the basin. The findings show how the hydro-power generation is correlated to dam inflows, which in turn is linked to the amount of precipitation and can be incorporated for planning of hydro-power supply.

**Key words:** stream flow, hydro-power, upper Tana River basin, ArcSWAT, dam inflow

### 1. Introduction

Streamflow of any river basin can directly be influenced by hydro-meteorological variables that are linked to climate change. Climate change is one of the world's greatest challenges of the 21st century. There is unanimous consensus in the scientific community that the world is going to get warmer in the future and the average weather patterns are expected to take a major shift (Godbole, 2014). A more variable climate is expected to be a direct result of increase in atmospheric concentrations of greenhouse gases resulting from human activities (Pilesjo and Al-

Juboori, 2016). Unequivocal evidence from in situ observations and ice core records shows that the atmospheric concentrations of important greenhouse gases such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O) have increased over the last few centuries (IPCC, 2014). Carbon dioxide and many other greenhouse gases occur naturally in the atmosphere and are important in keeping the earth warm. Anthropogenic sources of greenhouse gases have increased since the industrial revolution which has resulted into a significant increase in greenhouse gases concentrations in the atmosphere, this trend is expected to continue over the next century which will result into major rise in temperature greater than any time in the past (Pilesjo and Al-Juboori, 2016).

Over the past decade, the assessment of climate change impacts on water resources has been a major research effort. Climate change is expected to affect the hydrological cycle, and consequently, water balances and local water supplies. Predicting water availability under changing climatic conditions and hydrological variations, for both short-term and long-term, are essential for many social, economic and environmental sectors such as agriculture, industry, and biodiversity conservation (Li *et al.*, 2016). Climate change can cause significant impacts on water resources by resulting changes in the hydrological cycle. For instance, the changes in temperature and precipitation can have a direct consequence on the quantity of evapotranspiration and on both quality and quantity of the runoff component. Consequently, the spatial and temporal availability of water resources, or in general the water balance, can be significantly affected which in turn affects agriculture, industry and urban development.

The hydrologic system, which consists of the circulation of water between the oceans and the atmosphere, is an essential part of the global climate system. Changes in global climate are believed to have a significant impact on hydrological regimes and also bring about significant changes in severity and frequency of droughts and floods. For instance, snows and glaciers in Mount Kenya and Mount Kilimanjaro, which act as major water towers in Kenya and Tanzania respectively, are quickly receding due to continued rise in temperatures in the past century. These changing temperatures have been attributed to climate change (Droogers, 2009). Climate change has also led to decreased river flows especially during the dry seasons, which, as a result has severely affected hydropower generation across the country (Bunyasi, 2012).

Hydropower, largely considered as a clean renewable energy source, has provided many economic and social benefits to many countries in the world, such as improving domestic energy

supply, providing energy security and services, stimulating national economic development, and increasing economic growth. Hydropower is the main form of renewable source of energy world over and is increasing, the world's hydropower installed capacity and output increased by over 5.3% from the year 2009 to 2010 (Hamududu and Killingtveit, 2012). Hydropower supplies about 50% of electricity in 66 countries and 90% in 24 countries globally. In Africa, it is recorded that the effects of climate change are severely affecting hydropower plants especially in areas that experience low annual rainfall (Bunyasi *et al.*, 2013). Hydropower generation makes a substantial contribution to today's world electricity demands and it is the main form of renewable source of energy over the world. Hydropower accounts for 49% of installed electricity capacity in Kenya with almost all hydropower generated by the seven forks scheme (Droogers *et al.*, 2006).

Hydropower generation is progressively becoming susceptible to climate change related events and resultant processes like reduced reservoir storage capacity due to siltation (Walling, 2008). Climate change has led to more pronounced droughts in the past years, which has led to decreased river flows especially during the dry seasons, which has severely affected hydropower generation across the country. In addition to its impacts on snow and glacier, the continued rise in temperature have also increased the direct evaporation rates from the hydropower water reservoirs which is negatively affecting power generation. (Bunyasi, 2012).

### **1.1 Broad objective**

The broad objective of this research is to assess the trend of stream flow and its effect on hydro-power generation in the upper Tana basin.

## **2. Materials and Methods**

### **2.1 Study area**

The Tana River basin covers nearly 21 % of the total national landmass of Kenya, and has an aerial coverage of about 126,927 km<sup>2</sup> (Agwata, 2006; NEMA, 2013) (Figure 2.1). River Tana is the main river in the basin and it flows for about 1200 meters from the central Kenya highlands to Indian Ocean and it is the lifeline of the seven forks hydro-power project. Five major reservoirs have been built on the upper reaches: Kindaruma in 1968, Kamburu in 1975, Gitaru in 1978, Masinga in 1981, and Kiambere in 1988. Together, these provide three quarters of Kenya's electricity and regulate the river flow. The Upper Tana River basin covers the Aberdares highlands and Mount Kenya and is situated north-west of Nairobi with a surface area of approximately 12,500km<sup>2</sup>. The Masinga dam is the largest reservoir of the Seven Forks

hydropower project and therefore most important in controlling the Tana River system and the seven forks hydropower project.

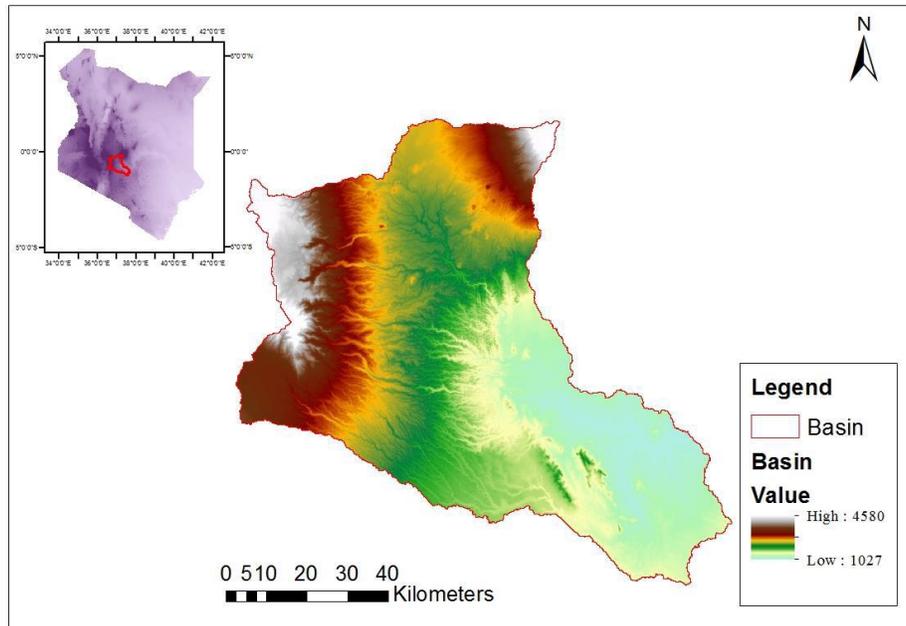


Figure 2.1: study area

### 2.1.1 Characteristics of the study area

**Topography:** The main topographic features in the catchment area are the Mount Kenya and the Aberdare ranges. Elevation ranges from 5199m towards the peak of Mt. Kenya to 400m in the east of the catchment. The southern slopes of Mt. Kenya and the eastern slopes of the Aberdare ranges are the main sources of rivers draining into the seven forks dam projects. Towards Mt. Kenya and the Aberdare ranges, the topography is rugged and sloping towards the Tana basin allowing for construction of hydroelectric dams. The slopes in the catchment are characterized by deeply dissected ridges and valleys which vary in altitude between 1,500m up to 2,400m, these dissections are further eroded by the rivers and runoff through erosion forming parallel valleys and ridges (Bunyasi, 2013).

**Geology and soils:** The geology of the upper Tana can broadly be divided into volcanic rocks in the north and west and pre-cambrian basement complex in the south-east. Other geologic formations of limited extend include igneous intrusions of granite and dolerite and an area of

quaternary sandstone between Murang'a and Sagana. The catchment has a broad range of soil types with varying water retention ability. Lithosols and Histosols occur at the highest altitudes in the Aberdare range, with Humic Andosols at slightly lower elevations. Nitosols are found in the mid-elevations and Vertisols in the lower elevations.

**Climate:** The climate ranges from semi-arid in the east to humid in the west. Generally, the area has a bimodal rainfall pattern with four fairly distinct seasons. The long rains occur between March and May while the short rains during September and November. The long rains and short rains are separated by about three dry months. Rainfall varies between 600mm in the eastern part of the watershed to over 2000mm on the Aberdare mountains. The maximum and minimum mean annual temperature varies between 25.5 – 31.00C and 21.0 – 24.00C respectively (Saenyi, 2012).

**Land use:** Agricultural activities are being practiced in the western area of the catchment where rainfall is higher, the rest of the area is used for grazing with only scattered cultivation. Maize, sisal, tea and coffee are the major crops grown in the area. Crop husbandry is low with only a few cases where physical conservation measures have been applied.

## **2.2 Data required for study area**

Climate data of the study area was obtained from the Kenya Meteorological Department (KMD), the data acquired include precipitation and temperature records for the 1983-2013 period. Water Resources Management Authority, (WRMA), provided data on Tana river flow discharge and stage at different locations along the Tana river, while the Masinga dam reservoir levels were acquired from Kenya electricity generating company, KenGen. Data on soils, land use and topography was downloaded from World Resource Institute (WRI), website.

### **2.2.1 Filling of missing data**

Every data series must be complete before the input to any hydrological model. Data missing can happen due to several reasons like gauge problem, difficulty in reading daily data, personal mistakes in storage, poor storage system and so on. The data series collected from WRMA and Ministry of Water, Kenya had so many missing values and mostly on a long regular series of more than 90 regular days and sometimes a year of missing data. Random missing data were

filled by simple interpolation while the long missing series were estimated using data from nearby stations.

### **2.3 Determination of Tana River flow regime**

The natural flow of a river varies on time scales of hours, days, seasons, years, decades and longer. To describe the characteristic pattern of the river flow, many years of observation from a streamflow gauge are generally needed. A 30-year stream discharge data for the upper Tana was obtained from the Ministry of Water and the Water Resources Management Authority (WRMA). Flow changes within the 30-year period were analyzed and discharge trends plotted. For determination of the variations in the river flow regime over the 30-year duration, the study period was divided into three 10-year periods starting from the initial study year, 1983 and ending in 2013. The flow regime of different streams in the watershed was established and therefore a general trend of stream flow over the study period established. The mean flow and the minimum peak flow was also determined. The ArcGIS software was used for analyses of catchment characteristics.

### **2.4 Relating river flow regime to hydropower**

Data on hydropower generation from 1990 to 2013 was obtained from KPLC and KenGen. The corresponding reservoir levels were established for each specific amount of power generated from the hydropower stations. Hydropower generation over the same period was plotted against time in years and the trend in hydropower generation observed. Water resource availability changes were converted and linked to changes in hydropower generation. The runoff is assumed to be the main determinant of limitation to hydropower generation. On average, runoff can be thought of as the difference between the precipitation and evaporation over long periods of time. The analysis methodology was based on the fact that hydropower generation is a function of flow ( $Q$ , in  $m^3/s$ ), Head ( $H$ , in  $m$ ) and efficiencies. Assuming that the changes in water resources will impact hydropower generated in the future, the most varying factor was the streamflow. The approach was based on the fact that the current hydropower generation system may only be limited by water availability. The main assumption was that if water supply reduced, the hydropower systems would likewise reduce generation due to decreased inflow in the reservoirs, and vice versa. With this approach, changes in annual and monthly mean flows were the main

predictors of hydropower generation. A relationship was then established between the hydropower generation and stream flow trends using regression method.

#### **2.4.1 Discharge versus hydropower generation analysis**

Hydropower technology allows for the transformation of about 90% of kinetic energy of flowing water into electricity. A flow rate of about 4000 liters per second is used to produce one kilowatt of electricity, assuming there is a vertical difference in elevation of 100m. Due to the fact that hydropower generation needs a continuous flow of water with minimum sedimentation, major dam constructions are usually necessary, particularly on rivers with high fluctuations in flow. Reservoirs created by damming of rivers regulate the river flow and also act as sediment settlement tanks. Constructing a dam across a river also causes a change in downstream river flow regime and water quality.

Generally, high amounts of precipitation in an area leads to high stream flow rates and consequently higher hydropower generation since the reservoirs will be constantly full of water, and therefore the channel flow and the power production will be positively correlated. However, deviations from these expectations do occur and are usually attributed changing climate and activities upstream the dam, including land use practices, that lead to poor vegetation cover and hence accelerated runoff or reduced flows due to diversion of water to other point uses such as irrigation.

#### **2.5 Simulation of river flow regimes and its effect on hydropower generation**

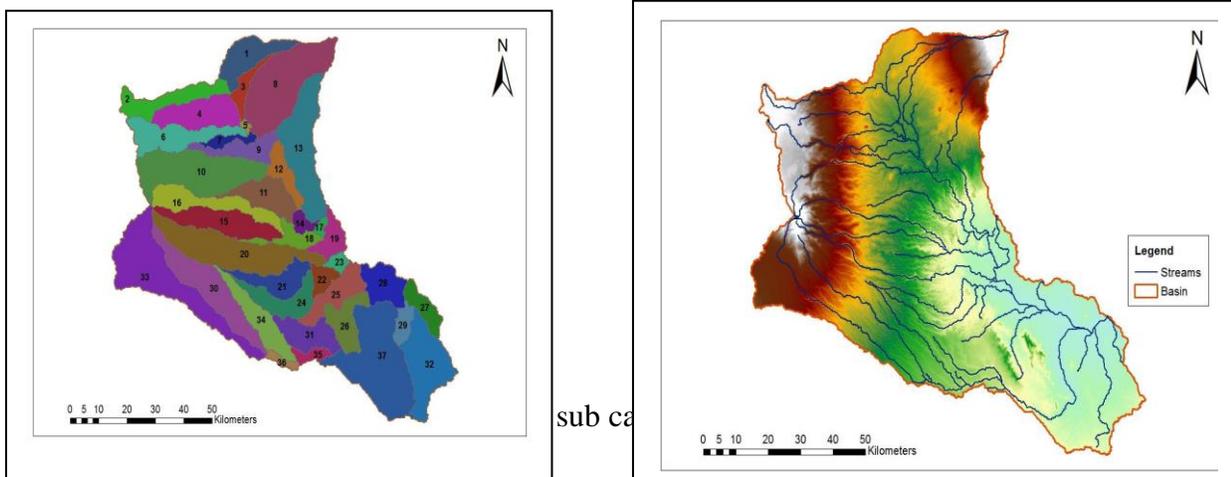
The ArcSWAT model was selected as the model for simulation of future stream flow characteristics. Soil, land use and slope characteristics of the study area were processed using the ArcSWAT model. The model was calibrated and validated in order to be representative of the real watershed characteristics. Future river flow scenarios were then simulated based on the predicted climate change scenarios for the upper Tana river catchment. Climate scenarios are used to provide quantitative assessments of climate impacts and can be defined as possible representation of future climate which have been developed to be used exclusively in conjunction with investigating the potential impacts of anthropogenic climate change (IPCC, 2007).

General Circulation Models (GCMs) are currently the most advanced tools available for simulating the response of the global climate system to changing atmospheric composition. In general, the GCM is a numerical representation of the atmosphere and its phenomena over the entire Earth and it incorporates a variety of fluid-dynamical, chemical or even biological

equations (IPCC, 2007). The GCM is run using different climate change scenarios and produces outputs of annual and seasonal averages, which enable the determination of the likely changes in precipitation, temperature and runoff as a result of these scenarios taking place.

## 2.6 Model input

The GIS input needed for the ArcSWAT interface include the Digital Elevation Model (DEM), soil data, land use and stream network layers. Data on weather and river discharge were also used for prediction of streamflow and calibration purposes. Topography was defined by a DEM that describes the elevation of any point in a given area at a specific spatial resolution. A 90 m by 90 m resolution DEM was downloaded from SRTM (Shuttle Radar Topography Mission) website on 20 February 2016 and projected using Arc GIS 10.2 software package. The DEM is one of the essential spatial inputs which was used to delineate the watershed and to analyze the drainage patterns of the land surface terrain. Sub basin parameters such as slope gradient, slope length of the terrain, and the stream network characteristics such as channel slope, length, and width were derived from the DEM. The surface area of the basin as calculated by the model was 7,026 km<sup>2</sup>, SWAT divided the watershed into 37 sub basins and 309 hydrologic response units as shown in the Figure 2.2.



SWAT model requires different soil textural and physicochemical properties such as soil texture, available water content, hydraulic conductivity, bulk density and organic carbon content for different layers of each soil type. Data for soil included the shape file soil map extracted from the soil map of Kenya available from Kenya Soil Survey. For each of the soil units in the study area, the soil physical and chemical properties were determined from the corresponding soil unit

identified from the table of the soil properties. Figure 2.3 and Table 3.1 shows some soil types and properties.

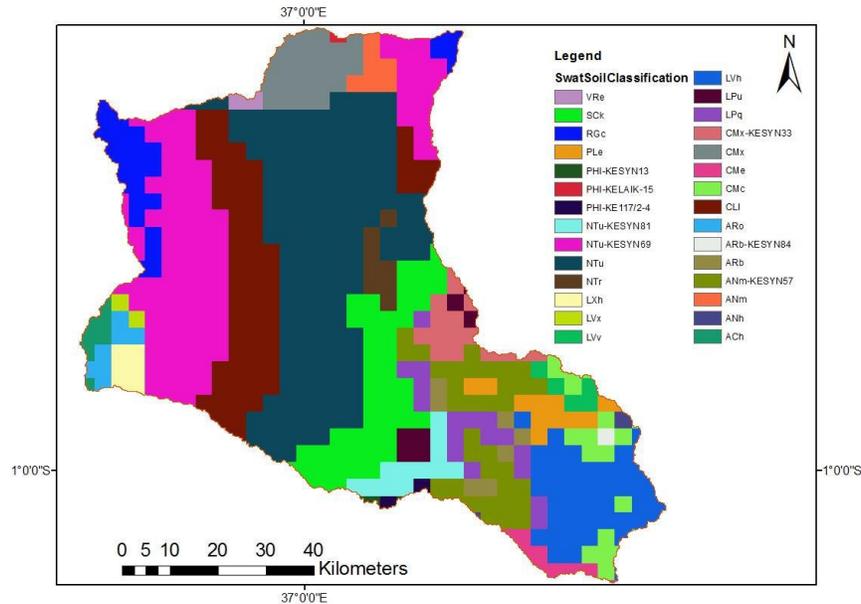


Figure 2.3: Soil map of Masinga dam catchment

Table 3. 1: Soils description

Soil code	Soil name	%sand	%silt	%clay	CEC	Bulk density	TAWC
NTu	Nitossols	7	31	62	21.4	1.10	23
HSs	Histosols	30	56	14	15	0.36	35.0
VRe	Vertisols	30	30	40	40	1.49	12
ANm	Andosol	59	20	21	33	1.13	17.0
PHI	Phaeozem	24	17	59	14	1.10	11.0

### 2.6.2 Land use

Land use is one of the most important factors that affect surface erosion, runoff, and evapotranspiration in a watershed. The land use shapefile of the study area was downloaded from MWI. The reclassification of the land use map was done to represent the land use according to the specific land cover types such as type of crop, pasture and forest Figure 2.4.

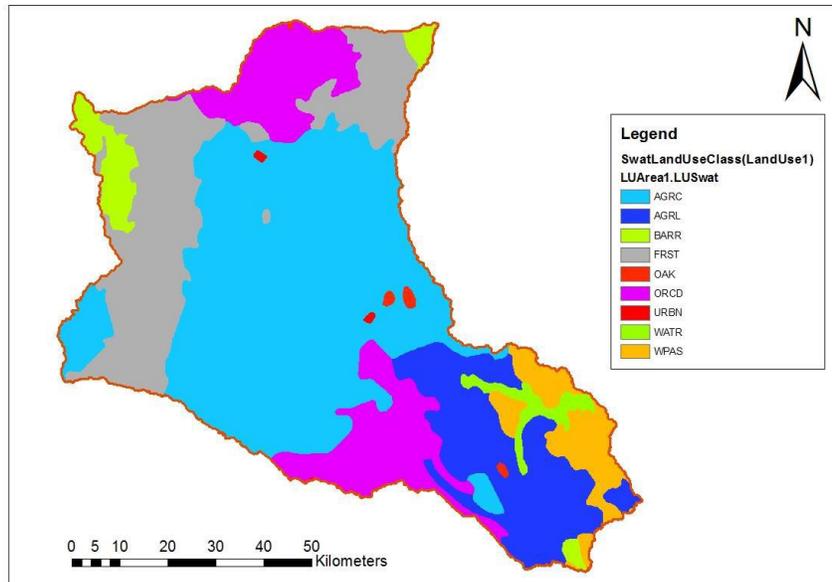


Figure 2.4: Land use map for Masinga dam basin

### 2.6.3 Discharge data

Daily river discharge values the Masinga catchment were obtained from the WRMA and the Ministry of Water. These daily river discharges were used for model calibration and validation.

### 2.6.3 Model simulation run

Having successfully loaded the required data, the model was able to run and produce the necessary output information on streamflow on a daily, monthly or yearly basis.

### 2.6.4 Model Setup

The model setup involved five steps: (1) data preparation; (2) sub basin discretization; (3) HRU definition; (4) parameter sensitivity analysis; (5) calibration and uncertainty analysis. Hydrological modeling using SWAT requires the use of detailed spatially explicit datasets on land morphology or topography, land use or land cover, soil classification and parameters for hydrological characteristics, and climate and hydrological data on a daily time-step (Schuol *et al.*, 2007). The DEM, Land cover and soil datasets were projected to Arc 1960 UTM Zone 37S by use of ArcGIS 10.2. Arc 1960 UTM Zone 37S is the Transverse Mercator projection parameters for Kenya. Using the DEM, the watershed was delineated by the use of ArcSWAT extension in the ArcGIS software. The watershed delineation process includes five major steps, DEM setup,

stream definition, outlet and inlet definition, watershed outlets selection and definition and calculation of sub basin parameters.

The model first defines flow direction and accumulation which is then used for stream network and outlets development. Upon selection of preferred basin outlet position, the model was able to delineate the watershed using the DEM and also develop sub basins. The sub basin parameters including area, perimeter and mean elevation were then calculated. In order to be incorporated into the ArcSWAT model, the Land use/Land cover spatial data sets were reclassified into SWAT land cover/plant types. A user look-up table was created to identify the SWAT code for the different categories of land cover/land use on the map as per the required format. The soil map was linked with the user soil database which is a soil database designed to hold data for soils not included in the United States. Subdividing the sub watershed into areas having unique land use, soil and slope combinations makes it possible to study the differences in evapotranspiration and other hydrologic conditions for different land covers, soils and slopes.

The soil, land use and slope datasets were imported overlaid and linked with the ArcSWAT databases. To define the distributions of HRUs both single and multiple HRU definition options were tested. For multiple HRU definition the ArcSWAT user's manual suggests that a 20 percent land use, a 10 percent soil and 20 percent slope threshold are adequate for most applications. To identify the most reasonable threshold level in the area the suggested threshold and other land use, soil and slope combinations scenarios were tested. These were 20% - 10% - 20%, 10% - 20% - 10%, 10% - 10% - 20%, 20% - 20% - 10%, and 25% - 30% - 20%. Each scenario was arranged in order of land use percentage over sub basin area, soil class percentage over land use area and slope class percentage over soil area. For example, if a 20% soil area is defined in HRU distribution, only soils that occupy more than 20% of a sub watershed area are considered in HRU distributions. Land uses, soils or slope that cover a percentage of the sub basin area less than the threshold level were eliminated. After the elimination processes the area of the land use, soil or slope is reallocated so that 100 percent of the land area, soil or slope in the sub basin is included in the simulation.

The ArcSWAT model to run, it requires input of meteorological data on daily time step. The weather parameters include precipitation, temperature, relative humidity and solar radiation for the study area over the study period. In absence of consistent daily data, the model is able to simulate the weather data using the weather generator model. The weather generator model requires input of average monthly weather data.

### **2.6.5 Model calibration and validation**

SWAT input parameters are process based and must be held within a realistic uncertainty range. The first step in the calibration and validation process in SWAT is the determination of the most sensitive parameters for a given watershed or sub watershed. The user determines which variables to adjust based on expert judgment or on sensitivity analysis. Sensitivity analysis is the process of determining the rate of change in model output with respect to changes in model inputs.

Sensitivity analysis in practical sense helps determine the predominant processes for the component of interest. Two types of sensitivity analysis are generally performed: local analysis, which entails changing one value at a time, and global sensitivity analysis, which involves allowing all parameter values to change. The two procedures, however, may yield different results. Sensitivity of one parameter often depends on the value of other related parameters; hence, the problem with one-at-a-time analysis is that the correct values of other parameters that are fixed are never known (Arnold *et al.*, 2012). The disadvantage of the global sensitivity analysis is that it needs a large number of simulations. Both procedures provide insight into the sensitivity of the parameters and are necessary steps in model calibration.

The parameter sensitivity analysis was done using the SWATCUP interface for the whole catchment area. Ten hydrological parameters were tested for sensitivity analysis for the simulation of the stream flow in the study area. Here, the default lower and upper bound parameter values was used. SWATCUP is a freely available computer program, which calibrates the swat model by linking it to several calibration algorithms. It provides user-friendly interface for sensitivity analysis, calibration and validation of the SWAT model output. Parameter sensitivities are determined by calculating a multiple regression system.

### 3. Results and Discussion

#### 3.1 Upper Tana River flow regime

The stream flow response to rainfall depends on the catchment attributes that include the physiographic, underlying geology, vegetation cover and rainfall amount, intensity, and frequency. The interaction between these attributes and the nature of the response are variable in space and time and induce complexity, which cannot yet be predicted in hydrology (Berhanu *et al.*, 2015). The complexity of stream flow response in a catchment can be addressed through the process of systematically organizing streams into groups that are most similar with respect to their flow characteristics. The temporal pattern of river flow over a period is the river flow regime, which is a crucial factor sustaining the aquatic and riverine ecosystems. A river flow regime describes an average seasonal behaviour of flow and reflects the climatic and physiographic conditions in a basin. Differences in the regularity of the seasonal patterns reflect different dimensionality of the flow regimes, which can change subject to changes in climate conditions. For analysis of the river flow regime, flow observation period was divided into three classes according to years of flow record, the first class included flow data from 1983 to 1993, the second 1994 to 2003 and the last division was in the period of 2004 to 2013. River flow regime for those periods were analyzed as presented in Figure 3.1.

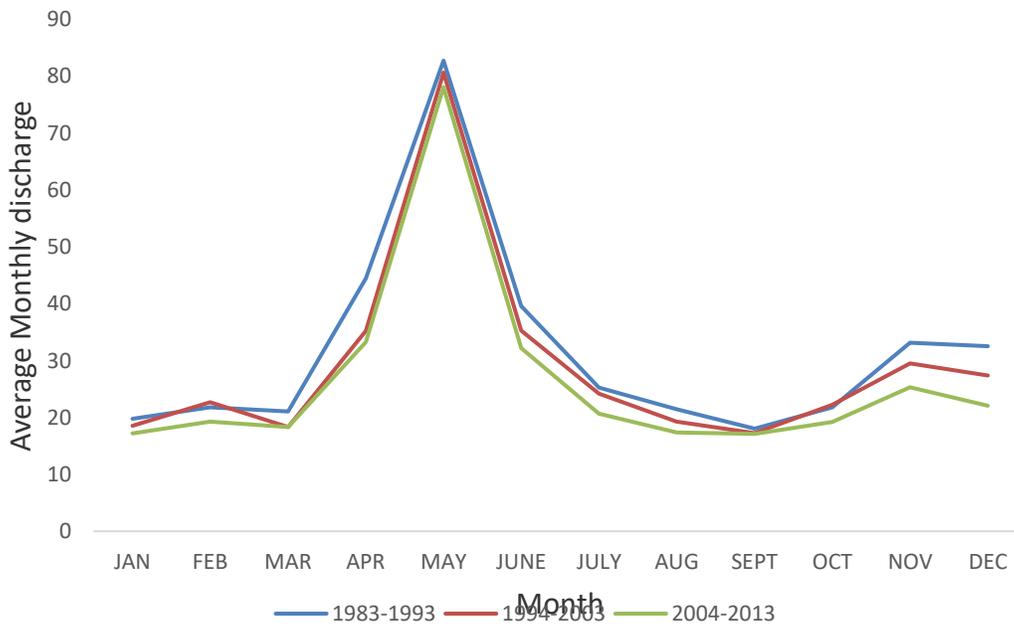


Figure 3.1: Tana-Sagana river flow regime

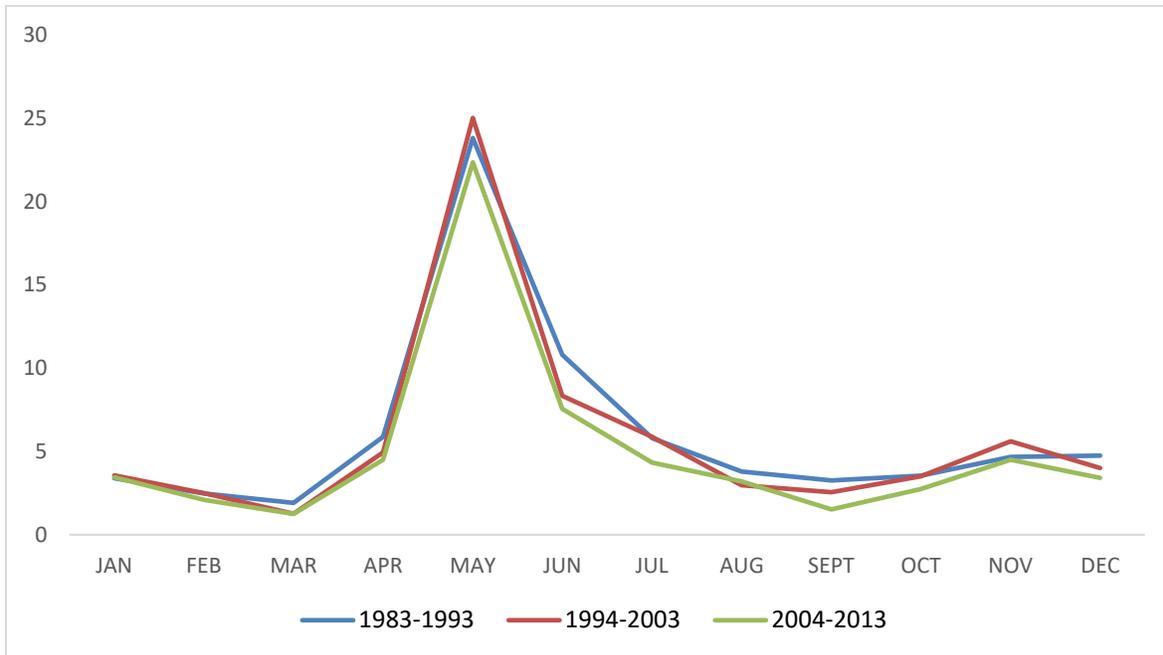


Figure 3.2: River Thiba flow regime

There has been a gradual decrease in the river discharge over the 30-year study period as shown by the Figures 3.1 and 3.2. The highest peak discharge, which occurs in the month of May has shown a gradual decrease over the years, with the first decade registering a high peak flow of 82.74m<sup>3</sup>/s in the Tana-sagana river followed by 80.65 m<sup>3</sup>/s in the following decade and finally a high peak flow of 78.1m<sup>3</sup>/s in the final decade ending in the year 2013. The decline in the streamflow over the years is basically due to decline in the amount of water flowing through the river channels. The reduction in the river flow can be attributed to decreasing amounts of precipitation and also the gradually increasing temperatures from the year 1983 to 2013 as shown in Figures 4.5 and 4.3 respectively, which can be attributed to climate change.

### 3.2 Effect of river flow regime on hydropower generation

For efficient and sustainable hydropower generation, water availability is an essential component. Changes in the river flow regime in a catchment can affect the amount of water available in the hydropower generating reservoirs which can in turn have an impact on the hydropower plants operation and electricity generation.

#### 3.2.1 Masinga reservoir inflow trends

The data of Masinga reservoir inflow was obtained from KENGEN, the data is based on the dam

test flows in cubic meters per second. The inflow rates were determined based on daily dam levels. Based on the trend analysis, the dam inflow rates show a steady decline as given in Figure 3.3

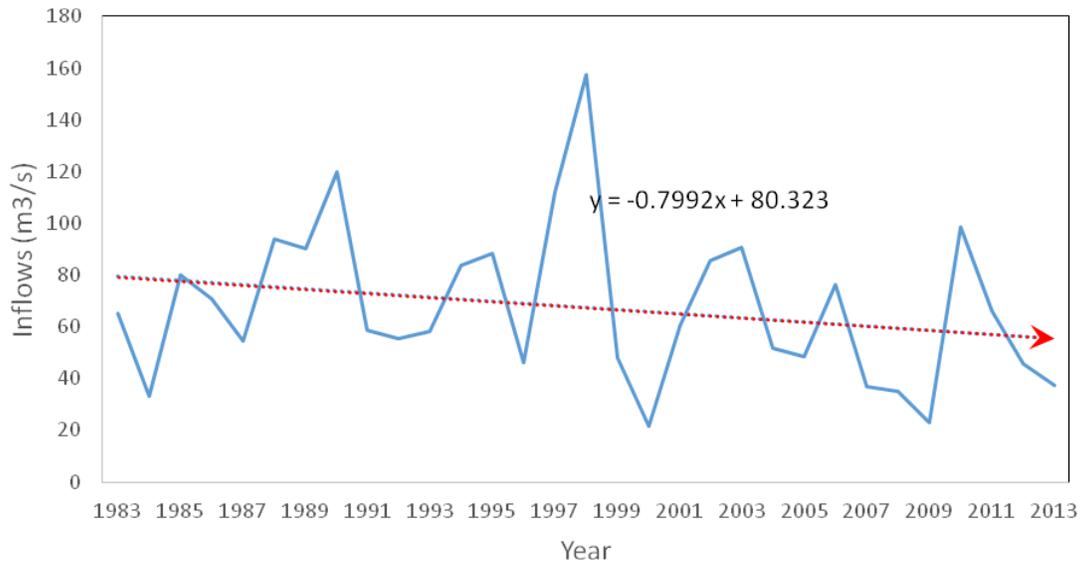


Figure 3.3: Masinga reservoir inflows

Masinga is the largest reservoir of the seven forks project but has the least power output at 40 MW. The main purpose of the dam is to store water, regulate flow during dry season, and control downstream flooding of the Tana River system. Just like the catchments precipitation trends, the Masinga dam reservoir inflows indicate a declining trend. This declining trend can hugely be attributed to the decreasing stream flow in the streams contributing to the reservoir recharge. The annual average dam inflows are declining at the rate of 0.7992 annually based on the trend line equation  $y = -0.7992x + 80.323$ . This means that the reservoir inflow is declining by 0.7992m<sup>3</sup>/s every year, in 30 years, the reservoir inflows have decreased by 23.98 cumecs. Based on Figure 4.8, lowest inflow rates are on the increase with the year 2000 and 2009 recording the lowest inflows of 21.4m<sup>3</sup>/s and 22.8m<sup>3</sup>/s respectively.

The highest inflow and the lowest inflow have occurred in the last two decades, in 1998 and 2009 respectively, this indicates an increase in extreme weather events like droughts and floods. During the 30-year period recording the lowest inflows on record at 22.8 m<sup>3</sup> (a year that Masinga plant operation was halted and the reservoir water levels declined to worrying levels). The major cause of variations in inflow is the alternating scarce and abundant rainfall pattern, high evapotranspiration rates and increasing catchment temperatures. Reduction in reservoir inflows

unswervingly threatens the operation of the Seven Forks Project, because Masinga reservoir plays regulatory functions for subsequent dams and sediment trapping as a more recent function.

### 3.2.2 Masinga dam reservoir levels

Daily dam reservoir levels were collected from the Kenya Power Generating company (Kengen) for the period 1990 to 2013. From the obtained data, the mean annual reservoir levels are about 1054m a.s.l. At this level, the dam operates at its optimum capacity. The minimum water level required for power generation is 1035m a.s.l (Saenyi, 2002). In general, the reservoir levels fluctuate between 1057.56m a.s.l which is the highest level to 1035m a.s.l. The water level, however, dropped to its lowest value ever recorded, 1018.68m a.s.l. in 1999/2000 due to a severe drought Figure 3.4.

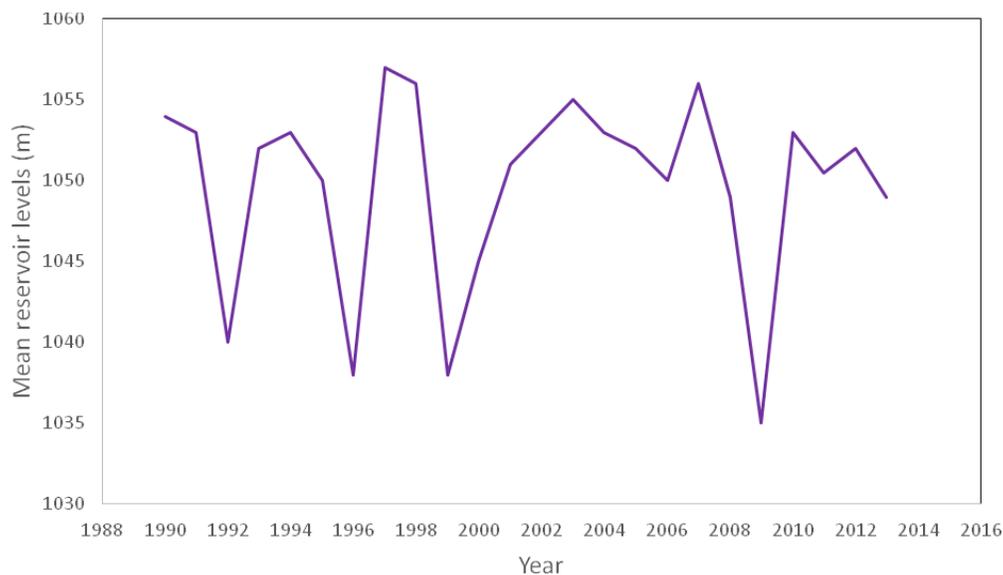


Figure 3.4: Masinga dam reservoir levels

High dam levels result of higher dam head efficiency and therefore less water is required for generating a single unit of energy. The higher the dam levels the greater the reservoir's surface area and thus higher water storage capacity. Subsequently, any drop in the dam levels adversely affect power generation especially during dry seasons where inflows are minimal. A decline in stream flow in the Masinga catchment located in the upper Tana river catchment have resulted to reduced inflows into the Masinga dam reservoir over the 30-year study period which has subsequently led to reduced reservoir levels. As shown in Figure 3.5, the years with the lowest dam inflows also exhibited lowest dam levels.

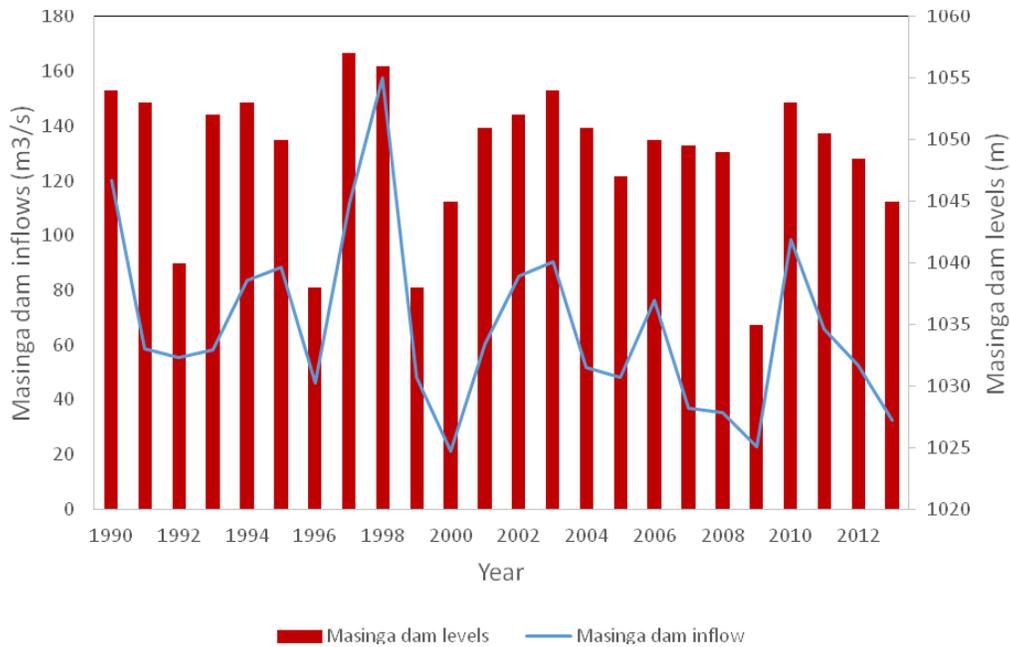


Figure 3.5: Relationship between dam inflows and water levels

Water is essential for hydropower generation; therefore a decrease in dam water levels will directly have an impact on the power output. Masinga dam is important in the seven folks project because it acts as a regulator of water inflows into the other dams. A decrease of water levels in the Masinga dam will therefore be reflected on all the other hydropower generating dams downstream Tana river. Figure 3.5 illustrates the trend of hydropower generation from the seven forks scheme. There has been a decreasing trend in the amount of hydropower produced in the scheme from 1990 to 2010, as shown in the graph. The driest years, which were 1999-2000 and 2009 recorded the lowest levels of hydropower generation. The hydropower generation was even halted for some months in those years because the dam levels declined below the threshold values. The figure also depicts a clear correlation between stream flow, dam water levels and hydropower generation.

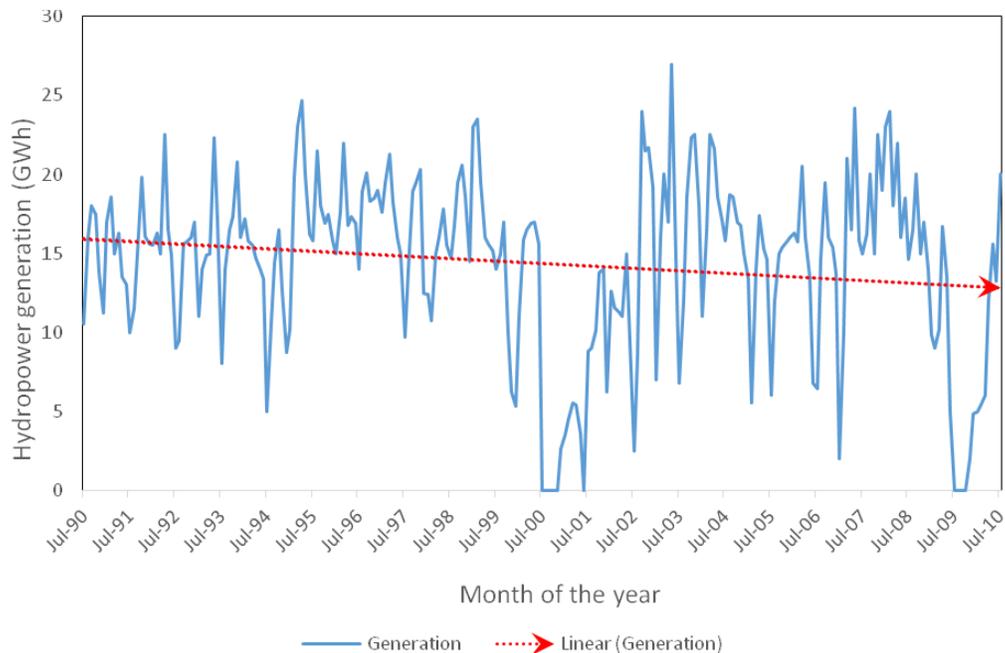


Figure 3.6: Hydro-power generation trend in the seven forks dams

Climate change effects on water resources and subsequently hydropower generation presents an intricate relationship which requires incised analysis to affirm the extent of climate change related events on sustainability of hydropower resources as a significantly reliable source of renewable energy in Kenya (Bunyasi, 2012). Decreasing amounts of precipitation and increasing temperatures have led to declining Masinga dam inflow rates as shown in Figure 3.6 which has led to decreasing hydropower generation over the years. Increasing temperatures will also stress the catchments floral biodiversity which may leave the soil bare and therefore susceptible to agents of erosion. Increased erosion rates in the catchment will lead to sediment deposition in the dams thereby reducing the reservoirs storage volume and also reducing overall dam operation efficiency.

Extreme climatic events like droughts and floods have also been experienced in the catchment with two major dry periods in 2000/2001 and 2009/2010. Occurrence of extreme climatic events threatens the sustainability and operation of hydropower generating structures. Figure 3.7 shows the relationship between annual reservoir inflows in million cubic meters with the changes in the energy output in each year during the long rains in the months of April, May and June. There is a clear correlation between the amount of inflows into the dams, which can be linked to amounts of precipitation as shown above, and the changes in power generation. Although the observed reservoir inflows in 2002 and 2003 were comparatively high, the changes in energy output were

not very significant. This is because these two years followed a very dry period on which the dam levels had reduced to critical levels and most of the inflow served to fill up the already depleted reservoir. This shows that occurrence of extreme climatic events, especially droughts is negatively impacting hydropower generation.

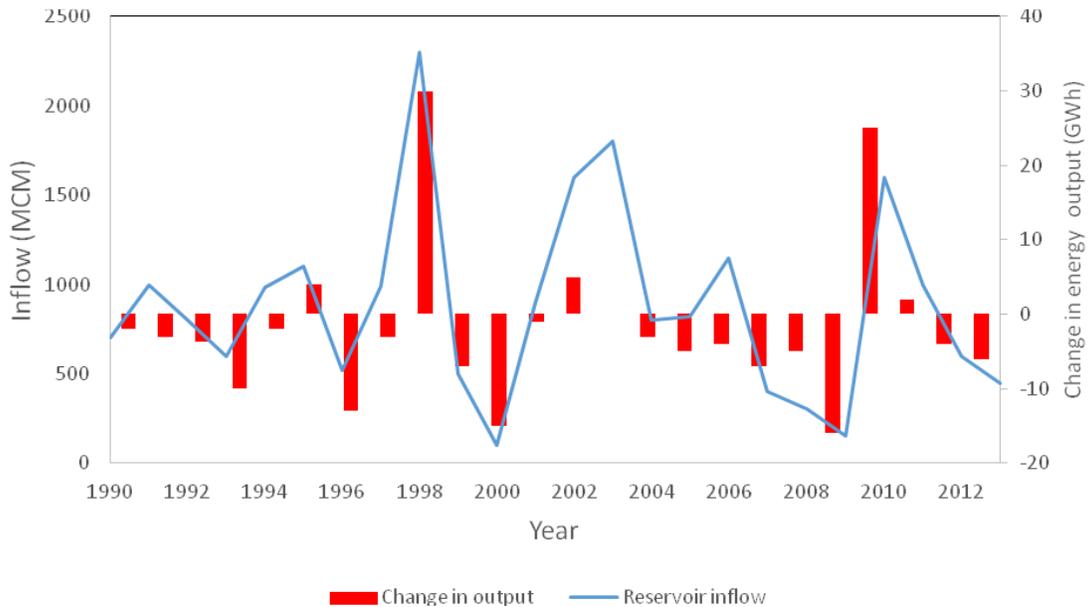


Figure 3.7: Changes in energy output relative to Masinga dam reservoir inflows

### 3.2.3 Projection of Streamflow using ArcSWAT

The ArcSWAT model database was updated to represent the expected changes in temperature and precipitation as predicted by (Gosling *et al.*, 2011). The model was then run for the reported changes in temperature and precipitation. Figure 3.8 below shows the model results for stream flow in the year 2100 compared to baseline period of 2010-2020.

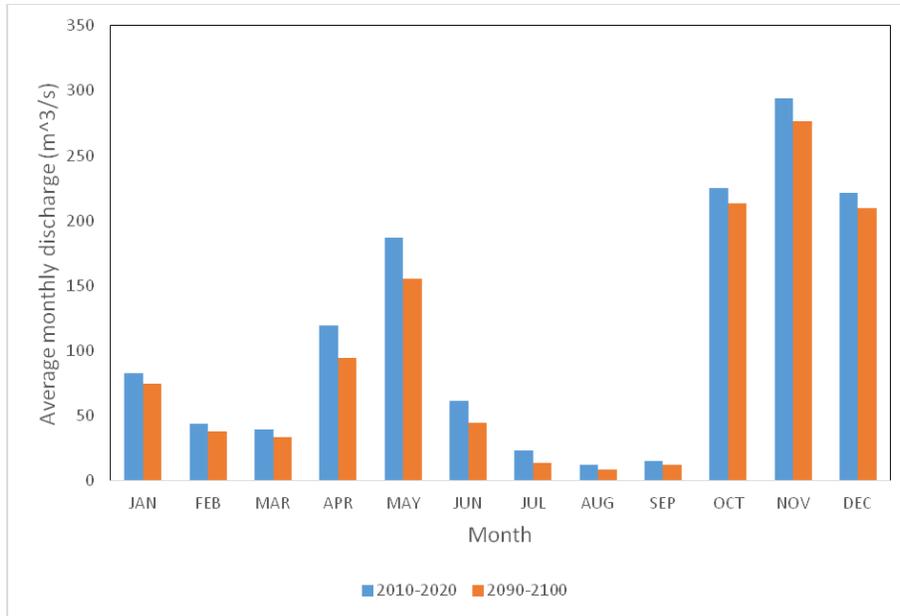


Figure 3.8: Simulated streamflow

From the Figure 3.8, a 3.5 increase in temperature will result in monthly stream flow reduction in every month of the year. The maximum flow reduction of 31.12m<sup>3</sup>/s was obtained in the month of May, with other wet months also recording major flow reductions. This shows that the climate change scenario will hugely affect the peak discharge of the Masinga dam catchment. The reduction of peak flow discharge can be attributed to the sporadic nature of precipitation together with high evaporation rates due to high temperatures. High flow changes during the wet months can be directly linked to low amounts of precipitation received in the area. The results above imply that in about a century's time, the mean monthly flow of the Masinga sub catchment will decrease by roughly 18 per cent, mostly as a result of temperature rise and changes in rainfall patterns and intensity. Reduction in stream flow directly affects the dam reservoir levels and hence hydropower generation. Hydropower generation basically relies on reservoir water level, which is directly affected by changes in streamflow upstream the dam.

With stream flow expected to continue declining in the future as a result of climate change, hydropower, one of Kenya's major supply of electricity is expected to be impacted by the declining flows. It is evident that hydropower generation from the seven forks dams has been decreasing over the years and that decrease is not expected to stop as future predictions show a further decrease in streamflow in the contributing basins. Climate change therefore remains a

threat to the sustainability of hydropower generation in Kenya and in general a setback in sustainable development.

#### **4. Conclusion**

The years 1999-2000 and 2009, had the lowest streamflows and lowest levels of hydro-power generation. Decreasing amounts of streamflow led to declining Masinga dam inflow rates and subsequently hydro-power generation. The findings show how the hydro-power generation is correlated to dam inflows, which in turn is linked to the amount of precipitation. Results from this study are useful in explaining the trend in hydropower generation in the basin. The projected future streamflows can be incorporated in planning of hydro-power supply in Upper Tana River basin.

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## **Innovation for Industrial Transformations Drivers and Barriers in Yobe State Construction Industries Nigeria**

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### **ABSTRACT**

The universal demand for industrial transformation in effective project delivery process led to the implementation of an advance innovative technology. However, a number of issues are increasingly becoming relevant with the industrial transformation. The most vigorous among them are the drivers and barriers to industrial transformation. The barrier that need to be addressed for an advance technology to be successfully implemented within the work domain are culture; given that different parties will have different cultures with their own sets of behaviours and working practice. Such pragmatic barriers are said to hinder effective industrial transformation among the parties, which in turn prevents the efficiency improvement within the project delivery process. Such interdependency for success, demands a suitable framework to improve collaboration, by attaining appropriate culture within the project-based industry. The purpose of this research work is to have deep understanding of drivers that facilitate the smooth industrial transformation and the barriers that hinder the industrial transformation in Yobe State construction industry in order to develop a suitable recommendation that will allow the management and employees to deeply understand the vital drivers and barriers for an effective industrial transformation. A set of solutions for managerial, integration and cultural orientations was developed. Empirical data were collected by questionnaire survey which was summarised and analysed using statistical analysis SPSS, and the key challenges of drivers and barriers on industrial transformation in Yobe construction industry were figure out. The empirical research findings are group into three depending on the responses from the questionnaire survey i.e. the industrial detail, the drivers and barriers to industrial transformation. And the outcome of the research shows that the majority of respondent are from private sector organisations that are in construction business for 5-10 years while Architect from design and engineering department in building construction an

**Keywords** – Innovation, Transformation, Project delivery, Culture, Implementation.

## 1.0 INTRODUCTION

There has been a great concern over the lack of efficiency and productivity in the construction industry worldwide. This has been attributed to so many factors, among which is fragmented process of design, procurement, construction, project delivery and facilities management. (Khalfan and Anumba, 2000). The need for continuous improvement to the conventional design and construction in the industry has been well documented in the literature. Several studies and government reports have enunciated the desire for the construction industry to be transformed from the way it performs its primary activities (Ibrahim and Price, 2006; Ibrahim, 2008).

The Nigerian construction industry is not free from such problems and even more. It has severally been characterized as inefficient with low productivity and lack of capacity to deliver and satisfy its clients. Oyewobi, (2011) attributed the drop in the Nigerian construction industry's contribution to GDP between 1980 and 2007 to poor performance and low productivity. Similarly, Idrus and Sodangi (2007) asserted that the Nigerian construction industry produces nearly 70% of the nation's fixed capital formation yet its performance within the economy has been, and continues to be, very poor. Among other criticisms facing the industry are time and cost overruns, (Kuroshi and Okoli, 2010; Ameh, 2011; Ogwueleka, 2011), inadequate planning and budgetary provisions, contract sums inflation, inefficient and poor service delivery, (Kolo and Ibrahim, 2010; Mohammed, 2012). Hence Aibinu and Jagboro (2002) and Oyewobi, (2011) emphasised the need for an innovation that would transformed the industry, for it to deliver value for money and effectively satisfy the needs of the clients.

There are several reactions to these calls for continuous industrial transformation in efficiency and productivity from different perspectives ranging from new contractual/procurement arrangements like partnering (Ibrahim and Price, 2006); to technological innovations in design and construction processes such as 3D CAD and modelling (Isikdag and Underwood, 2010).

Building information modelling (BIM) is one of such innovative processes that promise to bring about the much desired continuous transformation in the construction industry. BIM has been defined by Lee, (2006) as the process of generating and managing building data during its life cycle. Typically it uses three-dimensional, real-time, dynamic building modelling software to increase productivity in building design and construction. The process produces the Building Information Model, which encompasses building geometry, spatial relationships, geographic

information, and quantities and properties of building components. (Nederveen (2010). BIM has also been defined as the digital representation of the physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward (Building Smart, 2010). According to Becerik-Gerber and Rice (2010) BIM is seen as an enabler that may help the building industry to be transformed by improving its productivity and ensuring effective communication and collaboration between all project stakeholders from inception to completion of building projects. Several BIM related researches have been reported, especially those that have to do with its success stories and inherent benefits. There are numerous case studies (Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. (2011) that provide some evidence to support the fact that the use of BIM makes the building process more efficient and effective. According to Succar (2005) BIM has now solidified its position as a promising approach towards addressing the Architectural and Engineering Constructions (AEC's) numerous inefficiencies. Further, evidences abound that many countries of the world like USA, UK, Australia, Netherlands, Singapore, Hong Kong Finland, Norway, Denmark, Hong Kong (Yan and Damian, 2010; Isikdag and Underwood, 2010; Nederveen (2010; Wong *et al.* 2010; Sebastian and Berlo, 2011) and others have adopted BIM technologies at different levels and have experienced substantial improvement in construction project delivery. Some of the benefits of BIM technologies as claimed by its proponents are that it provides for efficient communication and data exchange (Nederveen (2010), auto quantification, improved collaboration, coordination of construction documents, improved visualization of design,( Olatunji 2010; Sacks 2010) clash detection, and cost reduction (Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. (2011) among others.

Considering the documented benefits of BIM, Olatunji (2010) stressed the need for its full adoption across all disciplines and geographical boundaries. Consequently, it becomes imperative for the Nigerian construction industry, which has been described as a 'sleeping giant' and having no capacity to deliver due to inefficiency and poor service delivery among other problems (Kolo, B. A., and Ibrahim, A. D. 2010; Mohammed, K. 2012), to exploit the widely acclaimed benefits of BIM technologies in order to practice in line with the global best practices and achieve the continuous transformation needed by its players.

However, despite the potentials and documented benefits of this innovative technology(BIM) not

much has been reported regarding its implementation in the Yobe construction industry. It is also not clear whether or not the industries are ready to adopt such technologies. Therefore, for BIM to be implemented in Yobe there is a need to identify the drivers' and the barriers that will hinder its successful implementation.

This research is aimed at evaluating the drivers and barriers for implementing an innovation for industrial transformation in the Yobe construction industry with a view to suggesting ways that will enable its effective implementation. The purpose of this research work is to have deep understanding of drivers that facilitate the smooth implementation of an innovative technology (BIM) that would aid in transforming Yobe construction industry and the barriers that hinder its implementation in Yobe State construction industry, and to establish their level of significance.

## **2.0 DEFINITION OF BUILDING INFORMATION MODELLING (BIM)**

BIM is a new paradigm with the result of tremendous transformation for every professional involved in the construction industry Harris, (2011) BIM is not just software; it is both a technology and a process. The technology component of BIM helps project stakeholders to visualize what is to be built in a simulated environment to identify any potential design, construction or operational issues. The process component enables close collaboration and encourages integration of the roles of all stakeholders on a project (Azhar, S., Hein, M., and Sketo, B.2008).

Several researchers have found that BIM is the process of creating a digital parametric model which represents the physical and functional characteristic of a building in full detail and further shared knowledge pool which can be used to form reliable decisions during the design, construction phases and throughout the life cycle of the facility (Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. (2011).

; Suranga and Weddikkara, 2012). To create relationship between objects with in a virtual building model BIM uses parametric object modelling technology. These relationships include

physical and functional characteristics as well as project life cycle information (Azhar, S., Hein, M., and Sketo, B.2008).

. According to Wong and Fan (2013) BIM consists of information representing the entire building and the complete set of design documents stored in an integrated database. Hence it is clear that all the information is parametric and thereby interconnected. If any changes to an object within the model automatically it will affect the related assemblies and constructions. Furthermore, Jayasena and Weddikkara (2012) added that, BIM is not a software application. Instead it is an IT solution for integration of software applications and IT tools to design a building in a common platform, a platform which is independent of the software we use. Therefore BIM can be clearly differentiated from traditional Computer Aided Design (CAD).

BIM as a lifecycle evaluation concept seeks to integrate processes throughout the entire lifecycle of a construction project. The focus is to create and reuse consistent digital information by the stakeholders throughout the lifecycle (Figure 1). BIM incorporates a methodology based around the notion of collaboration between stakeholders using ICT to exchange valuable information throughout the lifecycle. Such collaboration is seen as the answer to the fragmentation that exists within the building industry, which has caused various inefficiencies. Although BIM is not the salvation of the construction industry, much effort has gone into addressing those issues that have remained unattended for far too long (Jordani, 2008).

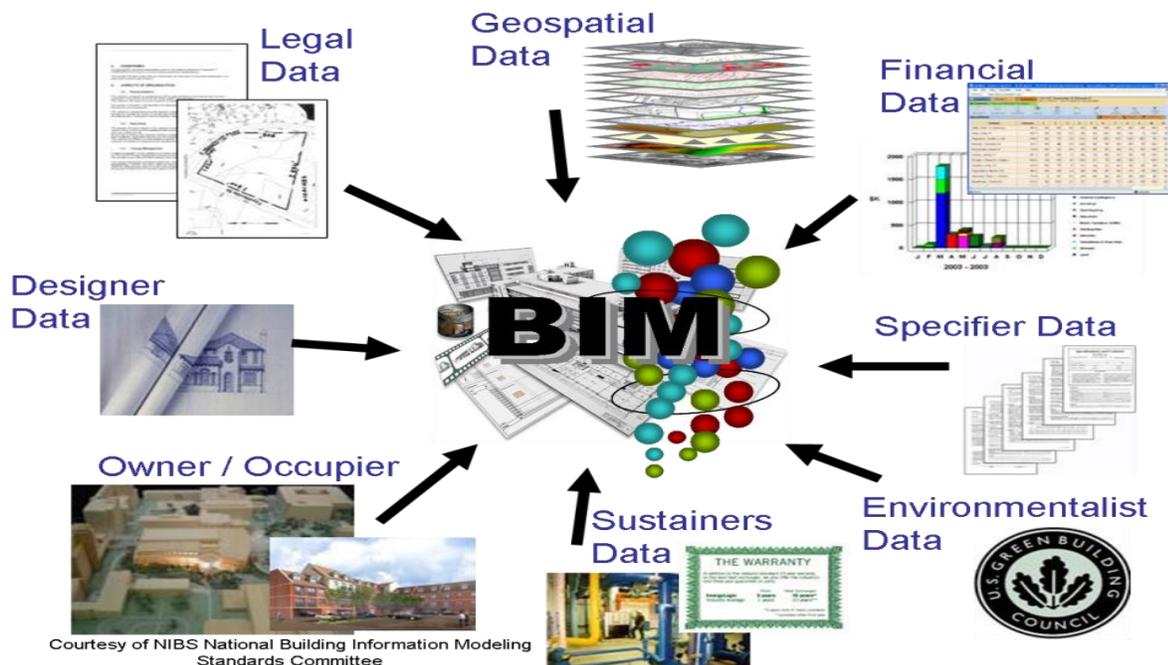


Figure 1: Communication, Collaboration and Visualisation with BIM model (NIBS, 2008)

It is vital to have thorough knowledge and understanding of the definitions of a Building Information Model and Building Information Modelling, in order to apply these in the construction industry, due to the fact there is no standard universally accepted definition of BIM as a result of that many definitions from different individuals of many backgrounds and professions came about, some of which are as follows;

Building Information Modelling (BIM) is a set of interacting policies, processes and technologies generating a “methodology to manage the essential building design and project data in digital format throughout the building's life-cycle (Succar, 2009, p.1).

A modelling technology and associated set of processes to produce, communicate, and analyse building models (Campbell, 2006, in Eastman, C., Teicholz, P., Sacks, R., and Liston, K. 2011., p.13).

BIM is the creation and use of coordinated consistent information about a project, information that enables you to visualise design in context, accurately predict performance, analyse real world structural behaviours and make design decisions earlier in the process all before the project breaks ground (Autodesk, 2009)

With few other variations Lee (2006) identified Building Information Modelling as the process of making and/or utilising a Building Information Model. According to this definition, Building Information Modelling is to be promoted as an essential tool that plays a major role in attaining the objectives associated with the construction project.

On the other hand, the definition of Building Information Modelling as a tool has been acknowledged. According to AIA (2007) BIM is defined as a digital, three dimensional model which are found to be associated with a database providing all aspects of project information. It is also promoted that BIM can blend with other criteria denoting construction project success, including design of construction, availability of information fabrication, instructions related to construction, and logistics related to project management in a single database. It encourages the blending of project goals throughout the project's design and construction.

Eastman, C., Teicholz, P., Sacks, R., and Liston, K. (2011) made a contradictory statement that BIM is not solely a software package, but a process. According to them, BIM can be identified as a modelling technology with well-knit procedures to create, interact and examine building

models. Building Information Modelling is a word utilised for the description of tools, processes and technologies that are associated with digital, machine readable documentation. This documentation is about a building, its functioning, its planning, and its construction and, last but not least, its operation. Hence, BIM is said to depict an activity and not any type of entity or substance.

Furthermore Ashcroft (2008) identified BIM to be the outcome of a modelling function which can be further described as a digital, machine-readable record of a construction, the related performance, the degree of planning and the delay in construction.

According to Hardin (2009) Building Information Modelling cannot be considered as a simple tool, but it a process involving the use of software to achieve the goals of construction project management. This is in agreement with the views of Eastman *et al.* (2011) they further present the view that a number of contractors proceed with a false conception that the purchase of BIM software automatically promotes integration of BIM software successfully in their operations.

Heesom and Mahdjoubi (2004) supported this view by indicating that there is lack of awareness among contractors with regards to the perceived use of BIM. Building Information Modelling not only comprises usage of three-dimensional modelling software, but also requires expertise and innovation on the part of the user.

Furthermore Howard and Bjork (2008) proffered that the moment a company begins to implement BIM technology it will begin to experience a change in its processes. Other procedures that have been suitable for CAD-type technology are not as good as BIM. BIM is capable of adapting to changes in any stage of construction and therefore is the ideal software tool which can be used by a construction organisation.

In line with these views, in this dissertation BIM is considered to be both software and a process which can be used to identify a number of parameters associated with the construction project. However, it is also important to note that the use of BIM involves adapting to the complexities of the project and requires expertise and innovation. As the technology is liable to change, so are the techniques and procedures of the technicians who are handling the technology.

## **2.1 BRIEF HISTORY OF BIM**

Both the concept and the term “Building Information Modelling” evolved through many years of research and collective works of professionals, academicians and researchers. Back in the 1980s

in the USA it was known as “Building Product Models” which was extensively used in the works of Professor Charles M. “Chuck” Eastman, one of the leading researchers and pioneers of BIM, and was believed to be the founding father of BIM (Laiserin, 2007, in Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. (2011, p.xiii). In Europe it was termed as “Product Information Models” almost at the same time to that in America, but the concept remains the same, not until later the two terms came together and with the verbal elimination of the word “Product” it became “Building Information Modelling” (Laiserin, 2007, in Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. (2011, p.xiii). The first publication in English of the new name was recorded in 1986 paper by then an employer of the GMW Computers Ltd, Robert Aish. However, the popularity of the term and concept BIM was due to the efforts of Jerry Laiserin and one of the earliest application of BIM as a tool was first done by Graphisoft in 1987 when they introduced the software ArchiCAD which is based on the virtual building concept.

## **2.2 BUILDING INFORMATION MODELLING (BIM) IMPLEMENTATION**

BIM is one of those innovations within the construction industry that is given the biggest trust in order to sort the problems that the industry is faced with (Granroth, 2011). But in order to not perceive BIM as a fashion several contextual issues needed to be dealt with. Adoption according to these contextual issues will lead to changes in the organisational level, with new methods and organisational structures, as well as at a business level, to deal with hindrances such as contractual issues (Gu and London, 2010), collaboration issues and the fragmented relay race that construction projects is today (Granroth, 2011).

According to Becerik-Gerber and Rice (2010) BIM is seen as an enabler that may help the building industry to improve its productivity by ensuring effective communication and collaboration between all project stakeholders from inception to completion of building projects. Several BIM related researches have been reported, especially those that have to do with its success stories and inherent benefits. There are numerous case studies. Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. (2011) that provide some evidence to support the fact that the use of BIM makes the building process more efficient and effective. For instance: greater integration and collaboration with other disciplines in the production process, adopting technology change to provide a more effective business process, effective intelligent real time response and moving into related building sectors. In addition a practical Case Study of John McCall’s Architects

(JMA) is attached as an appendix. According to Succar (2005) BIM has now solidified its position as a promising approach towards addressing the AEC's numerous inefficiencies.

Further, evidences abound that many countries of the world like USA, UK, Australia, Netherlands, Singapore, Finland, Norway, Denmark, Hong Kong (Yan and Damian, 2010; Isikdag and Underwood, 2010; Nederveen (2010); Wong(2010); Sebastian and Berlo, 2011) and others have adopted BIM technologies at different levels and have experienced substantial improvement in construction project delivery. Some of the benefits of BIM technologies as claimed by its proponents are that it provides for efficient communication and data exchange (Nederveen (2010), auto quantification, improved collaboration, coordination of construction documents, improved visualization of design,( Olatunji (2010); Sacks (2010) clash detection, and cost reduction (Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. 2011) among others.

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However, despite the potentials and documented benefits of BIM technologies, not much has been reported regarding its implementation in the Nigerian construction industry. It is also not clear whether or not the industry is ready to adopt such technologies. Therefore, for BIM to be adopted in Nigeria, there is need to identify the factors that will aid and those that will hinder its successful adoption, and the environment analysed to ensure some level of preparedness for its successful implementation. This research is aimed at identifying the influence of culture on the successful adaptation of Building Information Modelling (BIM) technologies in Nigerian construction industry with a view to suggesting ways of overcoming the impact in order to successfully adopt the improve technology. In order to achieve this, the study identified and assessed the enablers and barriers to BIM adoption in the Nigerian construction industry, to establish their level of significance.

### **2.2.1 ENABLERS OF BUILDING INFORMATION MODELLING (BIM) ADOPTION**

For the implementation of BIM there have been three major enablers. The first is the advent of enhanced IT infrastructure and capability of computers to develop and display 3D models with underlying large databases. The second enabler is the creation of the Industry Foundation Classes (IFC) by the International Alliance for Interoperability (IAI). The third is the increasing world wide support for BIM (Furneaux and Kivvits, 2008).

While according to Mu'awiya, A., Yahaya, M. I., and Kabir, B. (2013) the drivers of BIM adoption in the construction industry were identified as government support through legislation, clients' interest, software availability, cooperation and commitment of professional bodies, and collaborative procurement methods. All these have to be in place to enable successful transition of the industry to BIM working.

### **2.4 WHY BIM?**

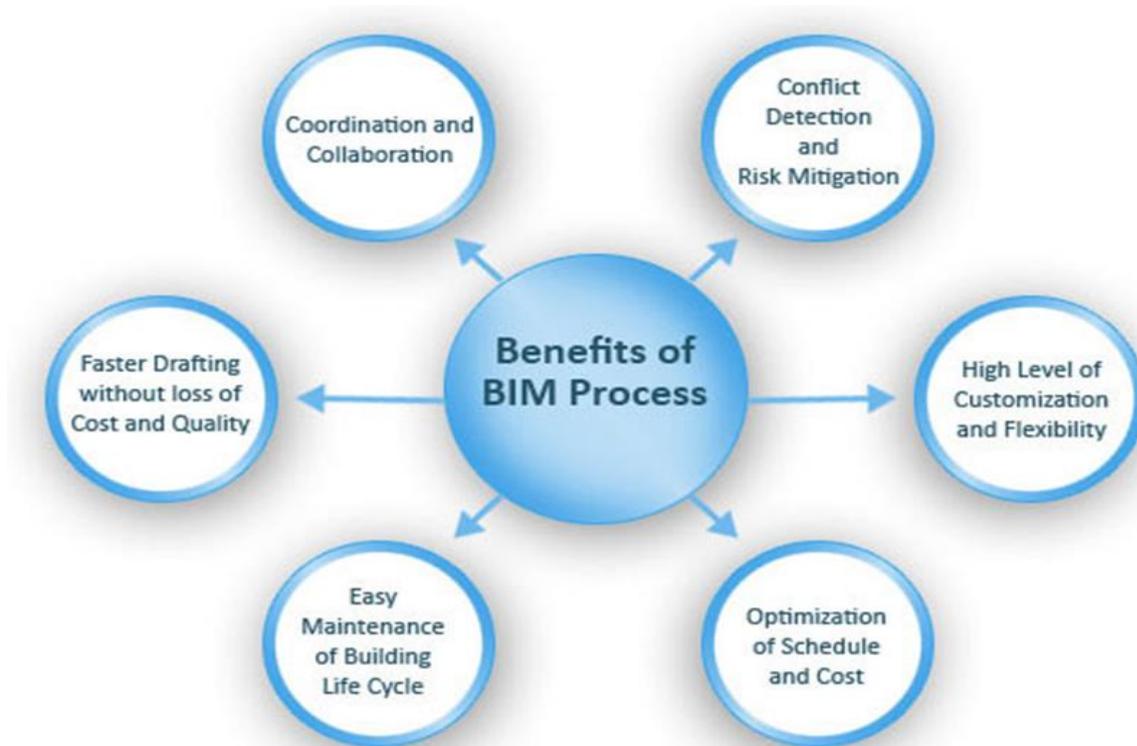
The need for continuous improvement to the conventional design and construction in the industry has been well documented in the literature. Several studies and government reports have enunciated the desire for the construction industry to improve and change the way it performs its primary activities. (Ibrahim and Price, 2006; Ibrahim, 2008). Yan and Damian (2008) observed that design of buildings has been done in the traditional way with the use of simple tools such as pen, paper and ruler, until the advancement of mathematics and building material science in the mid nineteenth century when engineers begin to use computers to produce 2D CAD drawings. Paper based communication was used between all project stakeholders on the construction industry with no platform for collaboration and clear visualisation of design. This has resulted to poor documentation and information management and has fuelled the fragmentation in the activities of the construction industry. It has further resulted to a lot of errors and wastes, which were considered part of the reasons for the poor performance, low productivity and inefficiency in the construction industry. A lot have been reported on the nature of complications in some forms of construction activities such as design errors, estimate deficiencies, conflicts between design and construction and fragmented platforms which limit information flow throughout project lifecycle (Olatunji(2010); Building SMART, (2010). BIM is seen as a solution to all these problems, as it serves as a platform for effective collaboration and communication between all parties to a building project.

## **2.5 BENEFITS OF BUILDING INFORMATION MODELLING (BIM)**

Broadly speaking, BIM has led to a significant improvement in the performance of construction industry professionals especially in design, construction and facility management. Yan and Damian (2008) opined that BIM did not only improve the technology itself, but changes the process of design and build. The following are some of the benefits of BIM as reported by researchers and practitioners.

- Simultaneous access to project database by all stakeholders.
- Robust information.
- Auto-quantification.
- Quality communication
- Multi-dimensional integration
- Project visualisation
- Project documentation
- Digital facilities management
- Clash detection
- Time and cost reduction (Olatunji (2010); BuildingSMART, 2010; Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. (2011).

Figure 2 represents the benefits associated with Building information modelling (BIM) as an integration platform of the entire project life cycle as opined by (BSA, 2007).



Source: <http://www.spatialiq.co.nz/Blog/Post/30/Why-WE-care-about-BIM--->

## **2.6 BARRIERS OF BUILDING INFORMATION MODELLING (BIM) ADOPTION**

Beside the versatile usage and tangible benefits of BIM, number of barriers increasingly arises during the adoption of BIM. While progressing with BIM adoption, complexity of the process is intensified, distribution of responsibilities and risks becomes unclear; more critical issues such as habitual resistance, fragmented information flow among the parties, contractual, and interoperability of software are raised (Rosenberg, 2007; Dossick and Neff, 2010; Sebastian, 2010; Andre, 2011). Ashcraft (2008), Andre (2011), and Udom(2012) asserted that the model related legal issues that make frontline obstruction in the open collaborative process are: data copyright, ownership of intellectual properties, confidentiality of data in a blended state, and signing the documents. Furthermore, the other legal issues which often hinder BIM adoption include inappropriate distribution of risks and rewards, responsibility of model development, model reviews and updates (Rosenberg, 2007; Sebastian, 2010; Andre, 2011; Azhar, 2011), undefined guidelines and insurance provision for software related error, data access, and model security (Ashcraft, 2008), lack of standard documentation and proven protocol (Gu and London, 2010; Andre, 2011; Udom, 2012). The major technical barrier is highlighted as interoperability

(Ashcraft, 2008; Gu and London, 2010; Sebastian, 2010; Azhar, 2011). Number of authors claimed cultural barrier as a critical hazard, as it involves potential obstacles that are human related (Ashcraft, 2008; Gu(2008); Yan and Demian, (2008). The human related barriers involve habitual resistance, inappropriate training, and lack of shared understanding (Ashcraft, 2008; Yan and Demian, 2008).

Furthermore, a pilot study by Mu'awiya, A., Yahaya, M. I., and Kabir, B. (2013) identified the frequent power failure and poor internet connectivity as barriers in the case of Nigeria.

## **2.7 ADOPTING BUILDING INFORMATION MODELLING**

Although many benefits can be gained by the implementation of BIM such as increasing constructability, reducing conflict and requesting for information due to having a good visualisation approach, reducing the time for cost estimation and increasing smooth coordination and information among parties in the construction projects, the pace of adoption of BIM is still slow (Khanzode and Fisher, 2000; Bernstein and Pittman, 2004; Kymmell, 2008 and Azharet *al.* 2008; NFB, 2012; Hannes, 2013; SCSl, 2014). This is because the majority of construction industry players see BIM as 'disruptive technology' that causes problems in the current construction process by transforming it into a new process according to Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. (2011) Therefore, the adoption of BIM is facing huge challenges from the construction industry players because they are reluctant to change the established traditional process. Challenges in adopting BIM can be classified into two categories which are non-technical and technical.

Basically, according to Arayici(2011) non-technical challenges are related to human being and organisational culture and these challenges include managing the resistance to change from people, making them understand how BIM offer them more benefits compared to 2D drafting, managing education and training people in BIM and explaining new roles and responsibilities of different stakeholders in BIM. As for technical issue, the most prominent issues arose are upgrading the technology, interoperability, compatibility and complexity (Fox and Hietanen, 2007).

### **2.7.1 ADOPTING BUILDING INFORMATION MODELLING IN NIGERIA**

The move to adopt Building Information Modelling in Nigeria's private and public sector (client side) and amongst different building professionals (Architects, Quantity Surveyors, Civil

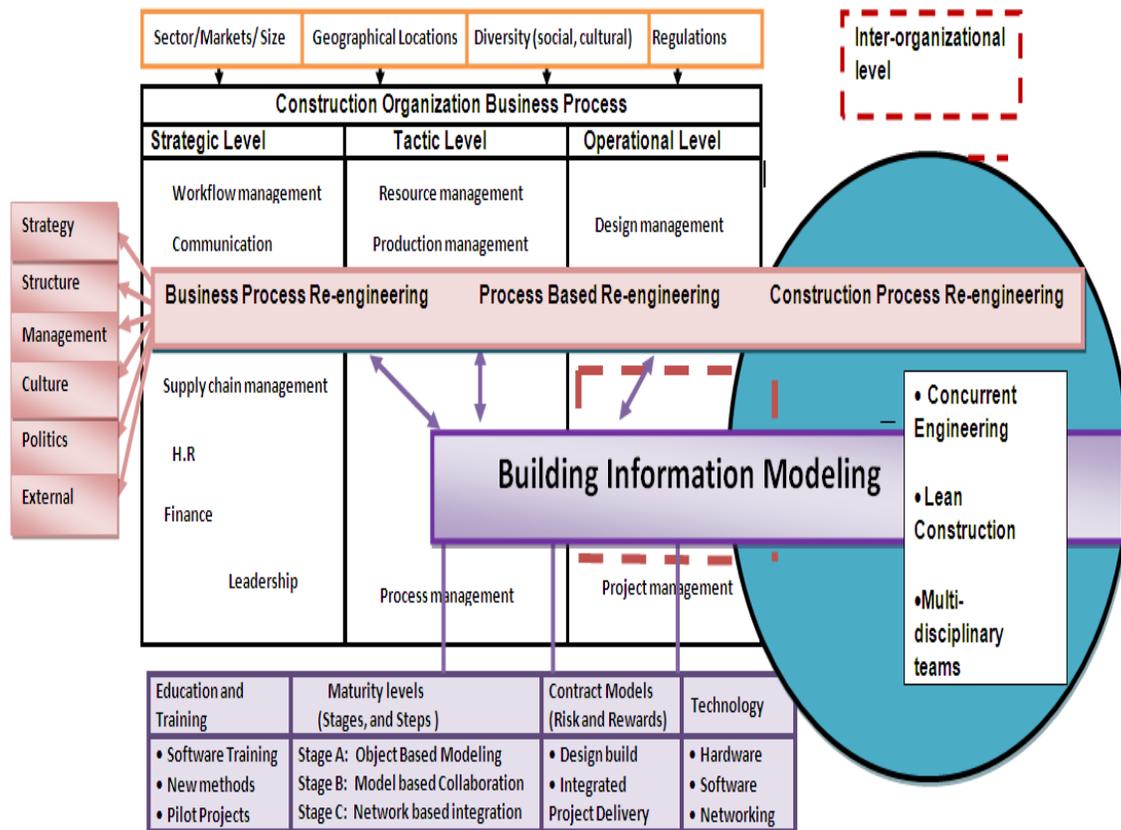
Engineers etc.) has been very slow. Architects have adopted but mainly for enhancing the visual quality of their presentation. This is unfortunate because of its enormous potentials to enhance efficiency, reduce disputes, save costs and curb corruption. The first step in promoting adoption will be to increase awareness of the technique, the tools employed and their benefits. Software vendors and training institutions have a role and commercial opportunity in promoting the awareness. Another critical step is for professional institutions such as the Nigerian Institute of Quantity Surveyors and the Nigerian Society of Engineers to organize training for their members and clients, including or perhaps especially public sector institutions. As this awareness grows the construction press and other informed opinion such as analysts will join in the promotion of the critical cost management tool that the BIM represents (Agele, 2012).

## 2.8 CONCEPTUAL MODEL

BIM provides a comprehensive mechanism to dynamically integrate different activities required for a construction project around a virtual model of a building. BIM provides a new way of design documentation practice by introducing new design deliverables and information exchange mechanisms which not only brings attention to the issue of sequence of development of building process but it also requires a virtual building representation i.e. a BIM model to be integrated into the design and construction process (Arayici (2010)). BIM approach thus entails a change in the building documentation process i.e. transition from architectural drawings as design deliverables to computerised model (Arayici (2010)).

Examining BIM enabled business process at intra-organisational and inter-organisational level requires tighter interaction and enhanced coordination between temporary project networks, alignment of modelling processes for creation and merging of BIM content between different project partners and timely and accurate accessibility of information to various activities involved in a BIM project (Taylor and Levitt, 2007). BIM is therefore, anticipated to bring paradigm shift in the project delivery through early involvement of design and construction project stakeholders (Hannon, 2007).

Based on the findings of literature review and industry wide survey, Figure 3 is developed which captures the dynamics of relationships between factors that play an important role during BIM adoption and implementation into an organization.



Source: First UK Academic Conference on BIM 5-9 September, 2012.

Figure 3: The factors effecting BIM adoption in the construction organisation.

#### 4.0 RESEARCH METHOD

The research methodology for this research is to a large extent quantitative, which indicates that the research process is largely deductive. Approaches were incorporated to provide alternate insight into the drivers and barriers to an innovative technology (BIM) implementation from the construction organisations and practitioners' viewpoint. This start with simple opinions and hypothetical insights was derived from literature. Research methods that were applied include a literature review, with the primary data collected through questionnaire surveys.

A review of literature was carried out for the purpose of articulating issues regarding the concept of an innovative technology (BIM) in the construction industries with particular emphasis on the Yobe state Construction Industries. The review aims at understanding the drivers and barriers for

the implementation of an advance technology (BIM) in Yobe state construction industry. The research involves the use of structured questionnaire as a tool for data collection, and was distributed to all building related firms within and around Yobe state. The firms were selected through random sampling method.

Data analysis was undertaken using statistical analysis in order to figure out the key drivers and barriers to an innovative technology (BIM) implementation in Yobe state construction industries. The result from the questionnaire analysis was presented in the form of chart and table which is significant to improve the research effectiveness and reliability (Johnson, 2012).

#### **1.4.2 DATA COLLECTION AND ANALYSIS**

The data needed to carry out this research work are:

The questionnaire based assessment technique was used to carry out the primary data collection. The questionnaire survey provides an insight into the likely future requirements of Yobe construction industry regarding the evaluation of the drivers and barriers for implementing an innovation for industrial transformation(BIM). While the secondary data was collected from sources such as newspapers, research articles, electronic databases, and so on. Descriptive analysis was made use of, so as to collect quantitative data's from the respondents. Result from questionnaire analysis was presented in the form of chart and table which is significant to improve the research effectiveness and reliability.

### **5.0 INTRODUCTION**

The problem in the Architecture, Engineering and Construction industry (AEC-industry) is presented as the increasing fall in construction output with respect to other (non-farming) industry. As described in the theory chapter, the researchers often argued that the reason for this problem is the high level of fragmentation in the AEC-industry, combined with its collaborative needs. In order to be able to complete a building project successfully many different actors have to be involved and contribute, hence the need for collaboration. BIM is presented as a way of addressing these issues by enabling better exchange of information within the project team and throughout the buildings life-cycle. However, to effectively implement BIM there needs to be a change in our culture and technique to project delivery, organizational cultures and information technology practices are required to assume a more essential part in firm performance improvement particularly in the construction organizations. This chapter present and discusses

the findings on Drivers and Barriers to an innovative technology (BIM) implementation in Yobe construction industries. The data presented are based on the outcome of the statistical analysis such as a descriptive statistic, frequencies, and so on with the help of Statistics Package for Social Sciences (SPSS), while the discussion on the results has been carried out to provide a clearer picture and understanding of the research.

Table 5.12: The potential barriers of BIM adoption in Nigeria

**Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
Unwillingness to initiate new processes	40	3	5	4.00	.641
Not enough opportunity for BIM implementation	40	2	5	3.75	.670
Benefits from BIM implementation do not outweigh the cost to its implementation	40	2	5	3.25	.670
Benefits are not tangible enough to warrant its use	40	1	5	3.42	.903
Inadequate infrastructure	40	3	5	4.10	.496
High cost of finance	40	3	5	3.95	.677
Poor data systems and lack of compatibility	40	2	5	4.13	.723
Absence of skilled personnel	40	2	5	3.57	.813
Culture (Attitude and behaviour toward change)	40	2	5	4.48	.640
Unfamiliarity of firms with the use of BIM	39	2	5	4.26	.677

Lack of standards to guide implementation	40	2	5	4.00	.751
Lack of knowledgeable and experienced partners	39	2	5	3.82	.721
Valid N (list wise)	38				

The above table show the descriptive statistics of the potential barriers of BIM. It is indicated that the respondent perception of potential barriers is across a scale ranging from 1 (Strongly disagree, Disagree, Neutral and agree) to 5 (Strongly agree). It is observed that different aspects including culture (attitude and behaviour toward change) (mean = 4.48, SD = 0.640), Unfamiliarity of firms with use of BIM (mean = 4.26, SD = 0.677), Poor data systems and lack of compatibility (mean = 4.13, SD = 0.723), Inadequate infrastructure (mean = 4.10, SD = 0.496) and Unwillingness to initiate new processes and Lack of standard to guide implementation (mean = 4.00. SD = 0.641 and 0.751 respectively) present an average mean score. This indicates that the majority of respondents felt these attributes to be major barriers of BIM adoption in Yobe state Nigeria.

These views are supported in literature by several authors. Ashcraft, (2008),Guet *al.* (2008) and Yan and Demian, (2008) claimed cultural barrier as an acute threat, as it contains prospective hindrances that are human related. Indeed these challenges may even be compounded in the developing world where infrastructural problems abound. In Nigeria for instance a pilot study by Mu'awiya, A., Yahaya, M. I., and Kabir, B. (2013)identified the frequent power failure and poor internet connectivity as potential barriers. While, Ayarici (2009) acknowledge on the survey conducted in UK that unfamiliarity of firms with the use of BIM as the primary barriers to BIM adoption.

However, the majority of respondents were of opinion that there is limited impact of BIM on the cost of financing the tool (mean = 3.95, SD = 0.677). The opinion was in line when considering the tangible benefits BIM will bring on implementation, which outsmarted the cost of financing the BIM software. Eastman, C., Teichoiz, P., Sackjs, R., and Liston, K. (2011) supporting this by explaining that clients are now realizing benefits that BIM can offer them as owners when adopted. While on contrast to the finding of the survey.Ayarici (2009) indicate high cost of software as the primary barrier to BIM adoption on the survey conducted in UK.

Additionally the majority of respondents questioned on the lack of knowledgeable and experienced partner for BIM implementation (mean = 3.82, SD = 0.721), Not enough opportunity

for BIM implementation (mean = 3.75, SD = 0.670), Absence of skilled personnel (mean = 3.57, SD 0.813), Benefits are not tangible enough to warrant its use (mean = 3.42, SD = 0.903) and Benefits from BIM implementation do not outweigh the cost to its implementation (mean = 3.25, SD = 0.670) by showing low score.

The finding from the survey was in contrast to those in literature. Ayarici(2009) reported that on a survey conducted in UK, reluctance to train staff or initiate new work flows, lack of opportunities to implement, and lack of proof for tangible benefits of BIM are identify as primary barrier.

Figure 5.12: Indicate how various potential barriers of BIM adoption in Nigeria are rated by the respondent in a bar chart below.

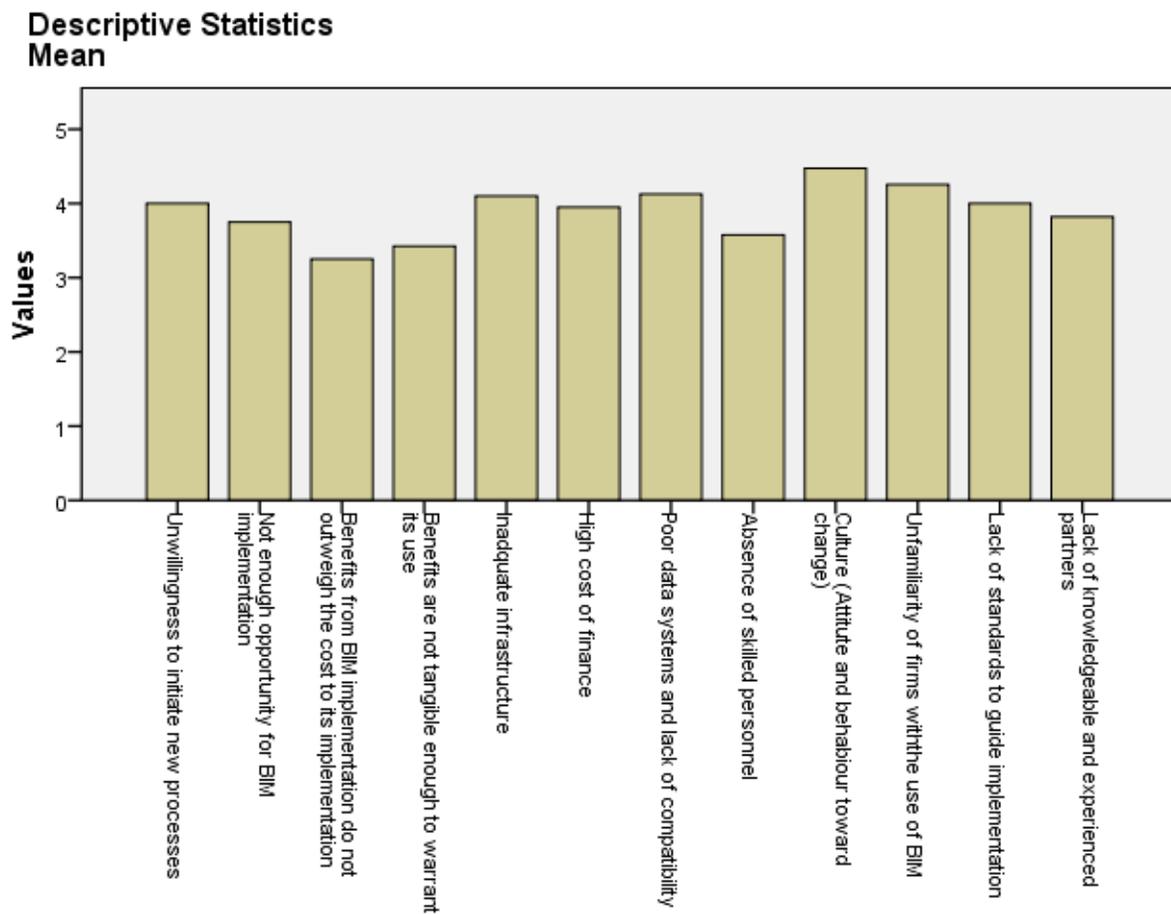


Figure: 5.12 the potential barriers of BIM adoption in Nigeria

Table 5.13: Drivers of BIM adoption

**Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
Attractive future plan	39	2	5	3.77	.777
Government Support	40	3	5	4.53	.554
External pressure and donor support	40	2	5	3.67	.730
Rising customers' expectations	40	2	5	3.45	.749
Technical change, modernisation and globalisation	39	3	5	4.28	.560
Client interest in BIM	40	2	5	4.00	.816
Software availability	40	3	5	4.43	.636
Cooperation and commitment of project team	40	2	5	3.67	.694
Adoption of collaborative procurement method	40	2	5	3.52	.751
Need to achieve cost savings and effective monitoring	40	2	5	4.13	.757
Desire to improve communication	40	3	5	4.03	.698
Reliable internet access	40	2	5	4.45	.714
Need to design health and safety into the construction process	40	2	5	3.78	.862

Valid N (list wise)	38				
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The above table show the descriptivestatistics of the Drivers of BIM adoption. It is indicated that the respondent perception of drivers of BIM is across a scale ranging from 1 (Strongly disagree, Disagree, Neutral and agree) to 5 (Strongly agree). It is observed that different aspects such as Government support (mean = 4.53, SD = 0.554), Reliable internet access (mean = 4.45, SD = 0.714), Software availability (mean = 4.43, SD = 0.636), Technical change, modernisation, and globalisation (mean = 4.28, SD = 0.560) Need to achieve cost savings and effective monitoring (mean = 4.13, SD = 0.757) and Desire to improve communication (mean = 4.03, SD = 0.698) present an average mean score. This indicates that the majority of respondents felt these qualities to be major drivers of BIM adoption in Yobe state of Nigeria.

These views are supported and questioned in the literature. Mu'awiya, A., Yahaya, M. I., and Kabir, B. (2013) identify the drivers of BIM adoption in the construction industry as government support through parliament, clients' interest, software availability, collaboration and commitment of professional bodies, and collective procurement process. Similarly, some of the views such as (Technical change, modernisation, and globalisation) were comparative to those in the literature. Furneaux and Kivvits, (2008) mention the advent of improved IT infrastructure and ability of computer to develop and show 3D models with underlying substantial databases as one of the significant enablers of BIM adoption.

Though, the majority of respondents were of opinion that Client interest in BIM (mean = 4.00, SD = 0.816) partially facilitates the adoption of BIM. The research finding on this aspect was in contrast to those in literature. As Mu'awiya, A., Yahaya, M. I., and Kabir, B. (2013) acknowledge Client's Interest in BIM as one of the potential drivers among others. Furthermore, Liu *et al.* (2010) further confirm that external forces from clients and competitors play a large role in BIM adoption. Similarly Robert *et al.* (2013) highlighted Client/competitive pressure as enablers to BIM adoption.

Moreover the majority of respondents questioned the Need to design health and safety into the construction process (mean = 3.78, SD = 0.862), Attractive future plan (mean = 3.77, SD = 0.777), External pressure and donor support and Cooperation and commitment of project team (mean = 3.67, SD = 0.730 and 0.694 respectively), Adoption of collaborative procurement method (mean = 3.52, SD = 0.751) and Rising customers' expectations (mean = 3.45, SD =

0.749) by showing low score. These views are in contrast to those stated in the literature. Mu'awiya, A., Yahaya, M. I., and Kabir, B. (2013) identify some of the aspect such as cooperation and commitment, Adoption of collaborative procurement method as potential drivers of BIM adoption. Similarly, Robert (2013) listed various authors such as Liu (2010), Azhar, (2011), Eastman, C., Teicholz., P., Sacks., R., and Liston, K. (2011), among others pinpointing some aspect like Need to design health and safety into the construction process, cost savings and monitoring as the potential drivers for BIM adoption in architectural engineering and construction industry (AEC-industry). Figure: 5.13 shows how various drivers of BIM adoption are being rated by the respondent in a bar chart below.

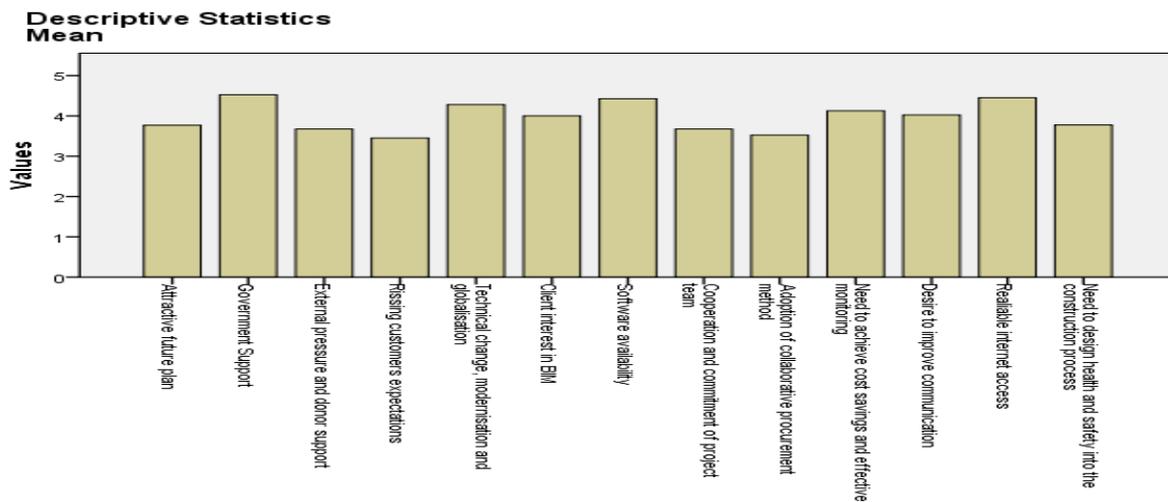


Figure: 5.12 the potential drivers of BIM adoption in Nigeria

## **CONCLUSION AND RECOMMENDATION**

The first objective, addressed in Chapter 2, outline the need for BIM implementation because industry requires dramatic improvements in efficiency, performance, strengthening margins, collaboration and knowledge sharing. The chapter describes history of BIM and reveals that BIM as a concept is in fact not that infant at all. Its roots reach as far as to early 1980's. Further highlighted in the chapter two that, the technology of BIM has benefits over traditional 2D technology. By improving the ability to manage information in construction projects, better collaborative work processes can be adopted. These processes can streamline the work in an Architect, Engineering and Construction project and thereby improving productivity. Improved productivity on a project scale is however not the only possible outcome of BIM adoption. BIM can be used at smaller scale by individual actors, with smaller potential benefits. The adoption of BIM must however correspond to the sought-after goal with the BIM adoption. BIM is not a goal by itself, the technology can enable changes in processes, making them more efficient, but BIM has no value in its own right. BIM has a value as a tool to reach other goals, but is not a goal by itself. Therefore the goal with BIM adoption must be developed before the processes for how the technology should be used are developed. The slow adoption of BIM is linked with many different barriers, and there is no single one problem that could be solved individually to enable wide scale BIM adoption. BIM will enforce a paradigm shift in the industry with large consequences to how construction projects are performed. With adoption of this new ICT technology more efficient work processes need to be adopted. How these new processes affect the industry in regards to business models and practises is currently not fully developed. The individuals working with these new tools also need education to be able to use the BIM tools. BIM will change many individuals' roles in the project and there has to be a general understanding of the changes in practice. Together this means that technical issues are not alone the greatest barrier to BIM. When trying to break down the barriers to BIM adoption it is important to remember the process changes and needs of the individuals actually working with the new tools. Organisations that undertake the construction. Unfortunately, changing competitiveness in the worldwide business sector has made difficulties for some organizations and people. To manage with this changing domain, organizational cultures and information technology practices are required to assume a more essential part in firm performance improvement particularly in the construction organizations.

Chapter 3 deliberated the general research paradigm in which highlighted the relationships in the conceptual model were to be examined and the research approaches appropriate within this paradigm. This chapter established arguments in respect of an appealing method involving a quantitative approach.

The data collected strengthened the fundamental relationships conceptualised in the model. The model therefore delivered a suitable basis for the development of the questionnaire. The questionnaire was designed to capture project features, measure change implementation.

In Chapter 5, the analysis of data collected was carry out to address one of the highlighted objective. In this chapter, descriptive statistics, and T-tests were used to deliver a picture of the construction organisations captured in the questionnaire survey. Correlation analysis were employed to explore and draw inferences about the relationships between the different barriers, drivers of BIM adoption in construction industries within the sample. The results indicated that the sample was generally representative of construction industries in Yobe.

## **RECOMMENDATIONS FOR INDUSTRY**

(a) Education and training were identified as important parts of BIM implementation due to the process and technological changes it brings in an organisation. Ayarici (2009). This research therefore recommends that BIM training programs should be provided by the academic institutions and other stakeholders in the construction industry to make our professional design consultants well acquainted with BIM processes to ensure successful take up of the technology. BIM should also be incorporated in the curriculum of all tertiary institutions in Nigeria taking construction related courses, in order to tackle the dearth of well trained professionals to handle BIM tools in the construction project organisations CPOs.

(b) It is recommended that Nigerian construction stakeholders including the government and professional regulatory bodies should work hand-in-hand in ensuring that the enablers of BIM adoption such as the provision of regulations and industry standards guiding the implementation are provided and strengthened to make the industry ready enough for BIM adoption.

c) Consultancy companies should further assess their capabilities and address all the issues highlighted in the different categories of willingness to create an enabling environment for them to fully adopt BIM in their practice

d) Through continued efforts in identifying ways to overcome the construction industry's resistance to transformation, by modifying traditional work habits, by improving current technical

limitations, and by encouraging the use of innovative ICT and Internet-based solutions, will undoubtedly help increase the overall knowledge, awareness and skills, of all industry stakeholders, in bringing about industrial transformation. This will result in a major social and technological impact that will integrate the construction industry in a unique, distinctive, and never before experienced way.

### **6.3 RECOMMENDATIONS FOR FUTURE RESEARCH**

Further research should be conducted to establish an in-depth awareness to all other sectors of the Nigerian construction industry for the barriers that hinders the adoption of BIM technologies. This is because the adoption cannot just be achieved by one section of the industry, but is a collaboration issue which needs all the sections of the industry such as contractors, clients, suppliers, manufacturers and government to have a fair level of awareness if the industry is to benefit from the adoption of the technology.

A framework should also be developed for the full adoption of BIM in the Nigerian construction industry.

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# Effect of Fly Ash and Superplasticiser on the Hardening Properties of Self Compacting-Concrete

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## ABSTRACT

The self-compacting concrete is a relatively innovative type of concrete that differs from the conventional vibrated concrete in that it contains a novel superplasticiser, Fly ash which contributes significantly to increasing the ease and rate of its flow and another advantage is that the novel superplasticiser is very cheap and available compared with the conventional one because it originated from waste material. It was first introduced in late 1980s in Japan when the researcher realized that poor compaction was the major contribution to the decline of quality construction work. Since then various research investigations have been carried out for establishing rational mix design methods in order to be self-compactable. The fresh concrete must show high fluidity beside good cohesiveness to make self-compacting concrete a standard concrete. This research presents the result of an experimental programme that has been carried out, aimed at investigating the fresh properties of SCC containing fly ash and novel superplasticiser. The fresh state properties of the concrete were evaluated. Finally, some hardened state properties of the concrete were assessed. Portland cement was partially replaced with 30%, 50%, 70% and 90% fly ash the water cement ratio was maintained 0.5 for all the mixes. Properties included workability, compressive strength, all were evaluated. The result indicated that the medium volume content of fly ash can be used in SCC to produce good strength concrete with this type of superplasticiser that originated from waste material. High absorption values are obtained with increasing amount of fly ash however almost all the specimen exhibits absorption of less than 5%. The concrete mixes contained 3 different dosages of a novel superplasticiser based on the carboxylic with and without fly ash. The percentage of dosage of superplasticiser is 0.25%, 1%, and 2% respectively. The increase in superplasticiser dosage from 0.25% to 2% the workability increases so the required slump flow meets the criteria of EFNARC also the result of mechanical properties compressive strength for 0.25%, 1% and 2% have shown significant performance compared with the control mixes.

**Keyword:** Self-compacting, concrete, novel Superplasticiser, fly ash, fresh properties.

## INTRODUCTION

The self-compacting concrete is a relatively innovative type of concrete that differs from the conventional vibrated concrete in that it contains a superplasticiser, Fly ash which contributes

significantly to increasing the ease and rate of its flow and another advantage is that the novel super plasticiser is very cheap and available compare with the conventional one because it originated from waste material (Krishna et al., 2012). A self-compacting concrete can fill any part of formwork only under its own weight, without the need for compaction or external vibration. This differ from conventional concretes in structural elements of complex and difficult shapes, e.g. congested working area or curved members, in which the conventional concrete maybe difficult to compact, especially in the congested reinforcement area . Goodier, (2003). Furthermore, SCC offers many health and safety benefits. The elimination of vibratory compaction on site means that the workers are no longer exposed to vibration and its related impact, e.g. waste energy spoil hand, besides providing a noiseless working environment. It was first introduced in late 1980s in japan when the investigator realized that poor compaction was the major contribution to the degenerated of quality construction work. Since then various researches have been conducted for establishing rational mix design methods in order to be self-compactable. (Aslani and Nejadi, 2012). Self-compacting concrete mixes can be possible with the use of local coarse aggregate without much effect for the mix designs. The fresh concrete must show good fluidity and good cohesiveness to make self-compacting concrete a standard concrete (Murthy et al,2012).

The SCC was also called high performance concrete. This was included in **Okamura's** definition (1992), which is shown below.

### **SELECTION OF MIX PROPORTIONS IN SELF COMPACTING CONCRETE:**

**In** designing for SCC mix, it is essential and useful to consider the relative proportions of the main components by volume than by the mass. The following key proportions for the mixes highlighted below Air content (by volume) ,Coarse aggregate content (by volume) , Paste content (by volume), Binder (cementations) content (by weight) , Replacement of mineral admixture by percentage binder weight, Water binder ratio (by weight) , Volume of fine aggregate volume of mortar , SP dosage by percentage cementations (binder) weight , VMA dosage by percentage cementations (binder) weight water binder ratio by weight, volume of the fine aggregate, volume of the water (Krishna et al., 2012).

## METHODOLOGY

### EXPERIMENTAL PROGRAMME:

The aims of the research are to investigate the hardening properties of self-compacting concrete containing fly ash and novel super plasticiser.

This STEP describes the materials used in the whole experimental, the mixing, casting, and curing procedures of concrete investigated in this study. The methods of measuring workability, density, compressive strength and, as well as the apparatus used, are also described.

All materials used throughout this study were the same. They were in accordance with relevant BS EN standards and were confirmed to be suitable for the scope of this st

Cement ordinary Portland cement is general purpose cement is one of the essential concrete components that bind the concrete ingredients all together. In order to attain more workable mix, an increased paste is required to realize the required deformability. The correct select of cement type is normally depending on the particular requirements of each application or what is presently being used by the producer rather than the specific requirements of Self-compacting concrete (Dumne, 2014).The cement used at this experiment work was general purpose Hanson cement used for casting the cubes for all samples mixes. The cement was of uniform colour that is grey with high greenish shade and was free from any impurities.

The fine aggregate (sand) used in the experimental programme was locally sand from river which package in bag for general purpose used as fine aggregate. The finest module of the aggregate used was like 2.44mm./Mixing water for concrete should be in good quality; it should not contain undesirable organic substances or inorganic ingredients above allowable amount. In the UK, water used in concrete mix shall conform to BS EN 1008. Therefore, tap water was used throughout the mixing and curing procedures for the concrete in this study.

The coarse aggregate used was graded aggregate 20mm maximum size and locally available river sand were used as natural coarse and fine aggregate respectively . Comprising crushed stone with a nominal size ranging from 5 to 20 mm.The physical properties of coarse aggregate like bulk density, specific gravity, gradation and fineness modulus are tested in accordance with BS 8882; 1992.

The Pulverised fly ash used in this experimental work was **EN 450-1 S GRADE PFA**Fly ash is an industrial waste that is generated after combustion of coal during the production of electricity.

These fine particles consist primarily of silica, alumina and iron. This type Fly ash is used to improve the durability and strength of concrete mixtures and make the concrete free flowing and sound.

Fly ash also acts as an industrial by product, generated from burning of coal in the thermal power plants. The increasing insufficiency of raw materials and the urgent need to safeguard the environment against the pollution has emphasized the significance of developing new building material based on industrial waste generated from coal fired thermal power station creating incontrollable disposal problems due to their likely to pollute the environment (Jino et al., 2012)

The admixture superplasticizer used for this experimental work was NJ100 is hydrocarbon super plasticiser base on grafted acrylic ester was also originated from waste material. Which were used throughout the mixes except for number one which is the control mix as Shows the detail in the table below.it was originated from Poly Ethylene acrylic acid (PEAA) collected from waste material Hexadecyl alcohol (HDA),Hexadecyl amine (HDM), Vinyl acetate (VA), Benzoyl peroxide (BzPO) and P-Toluene sulfonicacid monohydrate (PTSA) are from Aldrich Chemicals is used for evaluating the performance of the synthesized polymeric additives (Shafey et al., 2011).

### **MIXING:**

Tilting drum mixers were used throughout this study with capacities of 120 by, 90 litres with 220-240 volt ac, and 50HZ 1PH, which were chosen depending on the volume of the concrete batch needed. The concrete mixes were done in accordance with BS 1881-125:1986. The aggregates were added in the following order: initially about half of the coarse aggregate, then the fine aggregate and the residue of the coarse aggregate. The mixer was then started for 15 to 30 seconds. The mixing continued after adding about half of the total water for two to three minutes. All the cementations materials were then added and the mixing was continued. Then the remaining water was added after 30 seconds, continuing mixing until two to three minutes after all the materials were added.Total of 8 mixes were made to investigate the engineering properties of self-compacting concrete containing fly ash and novel superplasticiser .investigated were made, workability using j rings and L box,density,weight,. Detail of mixes are given in the table below for different proportional fly ash of 30%, 50%, 70% and 90% replaced with cement and superplasticiser in different percentage for other control 0.24% 1%, 2% respectively.

**TABLE 3.1 MIXES PROPORTION FOR THE RESEARCH EXPERIMENT.**

S.NO	MIX %	Cement kg/m <sup>3</sup>	Fly ash kg/m <sup>3</sup>	Fine aggregate kg/m <sup>3</sup>	Coarse aggregate kg/m <sup>3</sup>	Water kg/m <sup>3</sup>	s.p. gm/m <sup>3</sup>	w/cc
1.	<b>SP-0%</b>	<b>4888.5</b>		<b>16523.2</b>	<b>8811.4</b>	<b>4888.5</b>	<b>0</b>	<b>0.5</b>
2.	<b>SP0.25%</b>	<b>4888.5</b>		<b>16523.2</b>	<b>8811.4</b>	<b>4888.5</b>	<b>24.3</b>	<b>0.5</b>
3.	<b>SP I%</b>	<b>4888.5</b>		<b>16523.2</b>	<b>8811.4</b>	<b>4888.5</b>	<b>98</b>	<b>0.5</b>
4.	<b>Sp2%</b>	<b>4888.5</b>		<b>16523.2</b>	<b>8811.4</b>	<b>4888.5</b>	<b>196</b>	<b>0.5</b>
5.	<b>F30</b>	<b>6843.2</b>	<b>2932.8</b>	<b>16523.2</b>	<b>8811.4</b>	<b>4888.5</b>	<b>196</b>	<b>0.5</b>
6.	<b>F50</b>	<b>4888.0</b>	<b>4888.0</b>	<b>16523.2</b>	<b>8811.4</b>	<b>4888.5</b>	<b>196</b>	<b>0.5</b>
7.	<b>F70</b>	<b>2932.8</b>	<b>6843.2</b>	<b>16523.2</b>	<b>8811.4</b>	<b>4888.5</b>	<b>196</b>	<b>0.5</b>
8.	<b>F90</b>	<b>977.7</b>	<b>8799.3</b>	<b>16523.2</b>	<b>8811.4</b>	<b>4888.5</b>	<b>196</b>	<b>0.5</b>

**CASTING CURING AND TESTING:**

Cubes of 100mm in size were used for determination of weight, density, ultrasonic pulse velocity and compressive strength. where 50mm by 25mm used for determination of water absorption and capillary that is the 100mm cube divided in to two. That made the total number of 13 cubes two cubes divided it to half for capillary and water absorption. Before casting the workability test was made by the used of j ring and L box where the flow found satisfactorily because it flow under its own weight except for the control mix that is MO. Specimens cubes were then cast in steel mould and also no subjected to any compaction except for control mix again. The specimen kept covered in controlled chamber at 20 ±2°C FOR 24hours except those that have high percentage of fly ash that from 50% to 90% have delays for it setting time to 48hour even more then 2days for the mixes contained 70% and 90% fly ash Until remoulding .Thereafter, cubes were place in the curing tank at 20°C different age of curing 7days, 28day, 56day respectively. After then remove from the tanks take the weight, density ultrasonic pulse velocity, compressive strength water absorption, and capillary. For the determination of water absorption and capillary cubes were taking from curing tanks after certain age to place in an oven at 100°C until constant mass achieved this took me about 5days.the cubes were allowed to cool in an air tight bag container.

Measure the dry masses of the specimens was determined before they were immersed in water. For 0.02hrs 0.08hrs 0.17hrs, 1hrs, 4hrs, 24hrs, 72hrs, and 120hrs etc.



**FIG 2. SP-O CONTROL MIX NO ANYTHING. FIG 3. SUPER PLASTICIZER 1%**



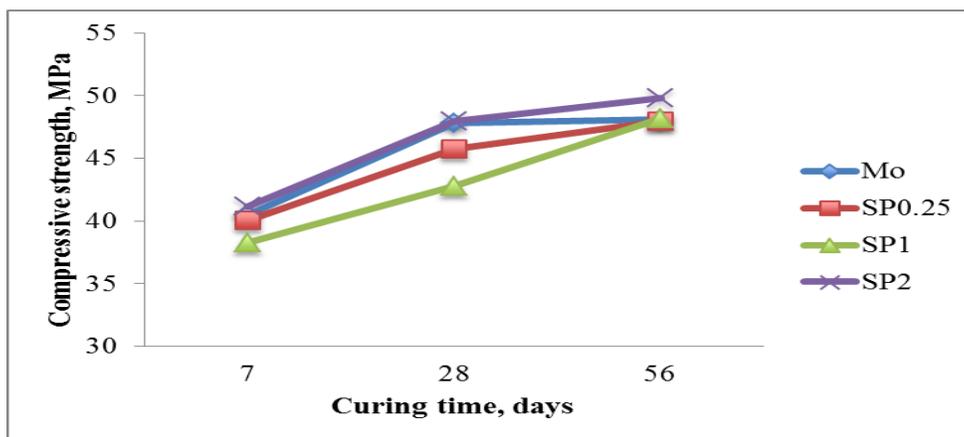
Fig 3.4 Fly ash with 70%

### **COMPRESSIVE STRENGTH TESTS:**

In order to investigate the effect on compressive strength when fly ash is added in to self-compacting concrete as cement replacement .in the cubes mixes contain different proportion of fly ash and novel super plasticiser were prepared and kept at curing thank for 7days 28days and 56days respectively the test was conducted on ASTH OF Capacity 3000KN.from the result table show below it is concluded that 56days strength of almost all the mixes is slightly higher than the corresponding 7days and 28days strength this is due to continuous hydration of cement with concrete.

### **COMPRESSIVE STRENGTH RESULT: WITH SUPER PLASTICIZER:**

	7days	28days	56days
Super plasticizer (%)	<b>Comp Strength (MPa)</b>	<b>Comp Strength (MPa)</b>	<b>Comp Strength (MPa)</b>
0	<b>40.47</b>	<b>47.85</b>	<b>48.13</b>
0.25	<b>40.06</b>	<b>45.75</b>	<b>47.93</b>
1	<b>38.25</b>	<b>42.79</b>	<b>48.22</b>
2	<b>41.14</b>	<b>47.97</b>	<b>49.8</b>

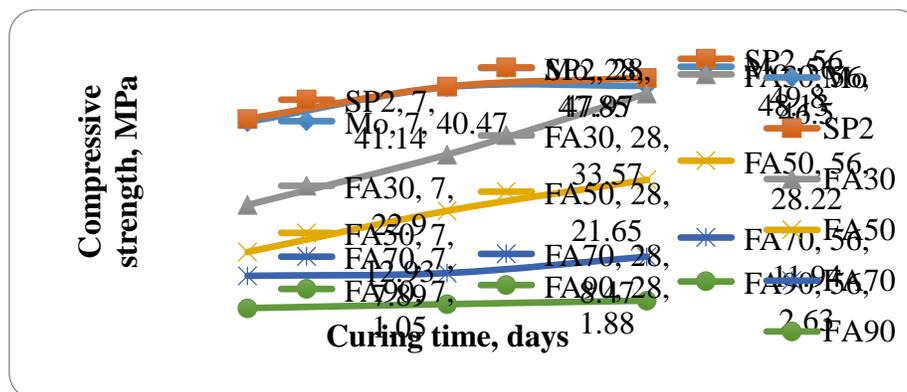


### THE EFFECT OF CONCENTRATION OF SP ON THE STRENGTH OF SCC

\*SP = Super plasticizer

\*M0= Reference without super plasticizer

	7days	28days	56days
Fly Ash (%)	<b>Comp</b>	<b>Comp</b>	<b>Comp</b>
	<b>Strength</b>	<b>Strength</b>	<b>Strength</b>
	<b>(MPa)</b>	<b>(MPa)</b>	<b>(MPa)</b>
30	<b>22.9</b>	<b>33.57</b>	<b>46.5</b>
50	<b>12.93</b>	<b>21.65</b>	<b>28.22</b>
70	<b>7.89</b>	<b>8.47</b>	<b>11.94</b>
90	<b>1.05</b>	<b>1.88</b>	<b>2.63</b>



**FIGURE 4.14:**

#### 4.4.2 THE EFFECT OF FA ON THE STRENGTH OF SCC IN PRESENCE OF SP2

Although with the use of novel superplasticiser the strength as you see in the table is not much differ compare with specimens of 7days and 28days more especially the different 28days of age of curing and 56days compressive strength except for those contain high proportion of fly ash that 70% and 90% the compressive strength is totally low which I can confidently concluded that fly ash equal to those percentage replace with cement is not advisable with this type of novel super plasticiser.

Effect of percentage of fly ash on compressive strength for self-compacting concrete the compressive strength test result s of SCC mixes as show in the above table with the increase of fly ash content the compressive strength become very low .However, compressive of self-

compacting concrete increase with the decrease in the percentage of the fly ash and water to cementitious material ratio. As you see in fig above the compressive strength at 50% fly ash the strength is more than half of that of the control mix. This low compressive strength value is expected at the early age of curing where there is not sufficient calcium hydroxide for the fly ash particles to hydrate. Based on the experimental result the low value is due to the high percentage of the fly ash applied to the mix the rate of hydration is very high that is why the sample contain 90% of fly ash by cement it dissolved unless keep it in an open space without put in water for curing because of the high content of fly ash that is why the compressive strength is very low. Furthermore, the observations from table result show that compressive strength of Self-Compacting Concrete contains fly ash and superplasticizer is increases relatively faster up to 7 days thereafter its rate becomes slower for same water-cement ratio. Generally, I can conclude that superplasticizer dose increases the compressive strength of concrete mix at both 7days and 28 days of curing.it has been observed that consistent increase in compressive strength could attributed due to addition of novel superplasticizer in concrete containing 30% fly ash with constant water-cement ratio. Furthermore, one can say that compressive strength increases rather than decreases though there is increase in workability of mix.



**MO CONTROL MIX NO ANYTHING SUPERPLASTICIZER 1%**



### **FLY ASH WITH 70%. CONTROL MIXES NO SUPERplasticiser.**

Time ranging 06-12 seconds is considered adequate for SCC (EFNARC 2002). The L- box flow times were in the range of 4-10second except for the control mix. The result of the investigation indicated that all SCC mixes meet the requirements of allowable flow time .based on the experimental result examined of the different mixes replaced by flash was further increase in workability as shown in mixes containing high percentage of fly ash the flow is within 800-900mm compare with the control mixture. Generally the use of fly ash in concrete reduce the water demand for a given workability .Therefore concrete containing fly ash will cause an increase in workability at constant water binder ratio. Furthermore, based on the investigation mixes containing high percentage of fly ash that is 70%-90% the workability is very high which it even lead to segregation as you see in mix contain 90% flash.

As in the result table above as the dosage of super plasticiser increases, the slump flow increases. This is expected because as the super plasticiser dosage increase the fluidity of the concrete also increase the L-box values increase as superplasticiser dosage increases this interpret that as the dosage increase concrete is more able to flow through reinforcement or congested side to fill everywhere on it weight.

### **CONCLUSION:**

The following observation and conclusion have been made based on the Finding result of the present investigations result:

With this type of novel superplasticiser high percentage of fly ash can be used to produce self-compacting concrete with adequate compressive strength. Using up to 30% fly ash as cement replacement can produce self-compacting concrete with the strength as higher as 40mpa.Higher

compressive strength has been obtained for fly ash replacement Of 30% also the increase in cement replacement Of 70% and 90% of fly ash resulted in a decrease in strength and increase in workability. Compressive strength is powerfully decreased with the increase of fly ash. Based on the result analysis the novel supeplasticiser modified used has substantial influence on the fresh properties of self-compacting concrete a small change in the dosage make a substantial change in the SCC properties that is flowing ability, passing ability, stability, and segregation resistance as in the result findings, the increase in superplasticiser dosage from 0.25% to 2% the workability increase so the required slump flow meet the criteria of EFNARC. Finally The 70% and 90% fly ash specimen is totally no good as you see in the result table though it achieved good workability on it fresh state .but the mechanical properties is very low and the developing setting it takes long time at least one week before final setting and when it immerse in water it dissolve because of high chemical reaction that were taking place which lead to degradation .I will finally concluded that 90% and 70% of fly ash is not recommended to use with this type of novel superplasticiser. The 50% contain of fly ash the mechanical properties that is the compressive strength it little bid well but no enough compare with the control mixes it need to be upgrade compare with the one with normal conventional superplasticiser for other researchers the strength is reasonable, but the fresh properties workability is very good.

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## Performance of Imputation Methods towards Increasing Percentage of Missing Values

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### ABSTRACT

The aim of this paper is to study the performance of eight different existing imputation methods used on simulated and real dataset. The methods are compared in terms of their ability to estimate the missing observations and estimate some statistics (mean, standard deviation and coefficient of a regression) using the full data set completed by the imputation. The comparisons are made using root mean square error, mean absolute deviation and bias observed after estimation of statistics. Simulation results using specific simulated data and bootstrap show that Mean Imputation and Complete case analysis are the best method in completing the data set and in obtaining best estimators for statistics. However, the results are subject to major changes if parameters like sample size, number of replication and type of distribution chosen are modified. In short with real data, results will change depending on the structure of dataset to impute. For example, application of the simulation results to a Rwandan dataset on smallholder farmers revealed that k-NN is the best method in reconstructing and Multiple Imputation can be used as imputation method in case we are to estimate some statistics. Our final conclusion is that imputation methods cannot be compared since in most cases their performance is parametrically linked to the data. We finally proposed a methodology and a simulation protocol to identify for any data set which imputation method will give the best results and therefore should be applied in priority.

**Keywords:** Bias, Bootstrap, Imputation, Root Mean Squared Error, Mean Absolute error.

## **1. Introduction**

Missing data is a common problem in applied statistics when dealing with collected data. It is a classical problem in all areas of research including: biology (Troyanskaya O et al, 2001), medicine (Lewis HD, 2010), climatic science (Schneider T, 2001) and others. Nearly all standard statistical methods presume complete information for all the variables included in the analysis. However, a relatively few missing observations on some variables can dramatically shrink the sample size and affect the quality of estimators produced from those data (Marina Soley-Bori, 2013). After data collection where sampling has been done properly, often the data set will come with blank spaces meaning that some questions have not been responded to during survey or some specific information were not collected properly. This situation raises one main question: how can we manage the units with the missing information?

Many researchers have proposed steps to study the problem of missing data, starting by the missingness mechanism, why some observations are missing? Then follows the decision between dropping units with missing observation or imputation. Finally, in case imputation is chosen, which imputation method to adopt considering the situation.

This paper aims to analyse the performance of imputation methods toward an increasing percentage of missing values and draw the related conclusion on comparing imputation methods. The paper is organized as follows: Section 2 discusses the missingness mechanism with some typical examples and implication of having missing data in the set. Section three presents some of the most used imputation methods including the most recent like Multiple imputation and weighting. Sections 4 and 5 investigate and discuss the simulation and the results obtained from simulation. Finally, section 6 concludes and introduces different uses of imputation methods beyond replacing missing data.

## **2. Missingness Mechanism**

Early works on missing data were carried out by Rubin (1987, 1996). Close to that, some researcher like Afifi and Elashoff (1966), Hartley and Hocking (1971), Ochard and Woodbury (1972) and Little (1971) did a bit more on the topic with some applications in different areas of study. Most of these works started with the missingness mechanism.

Prior to presentation of general imputation methods or how to handle missing data problems,

it is good to know why these data are missing. We present different missing data mechanisms, meaning how in our data base missing values appeared? There are 4 main situations where data can be missing:

- ✓ Missingness completely at random (MCAR): the probability of missingness is the same for all unit in the sample. For a given variable  $X$  in the data base, the probability for an observation to be missing does not depend on  $X$  itself and on other variables of the same data base. The perfect example will be if the choice is given to respondent to answer a question or not given a random condition (rolling a dice for example). It is difficult to have this situation in the real survey but it is the most common hypothesis in simulation or with real data imputation (Briggs et al., 2003; Allison, 2001).
- ✓ Missingness at random (MAR): Most missingness is not completely at random, as can be seen from the data themselves. Probability can depend on an auxiliary variable in the same survey. Respondent can decide to answer or not, or interviewer may forget to ask some questions to respondents. A more general assumption, missing at random, is that the probability a variable is missing depends only on available information. Thus, if for example sex, race, education, and age are recorded for all the people in the survey, then “earnings” is missing at random if the probability of nonresponse to this question depends only on these other fully recorded variables (Allison, 2001; Gelman & Hill, 2006).
- ✓ Missingness that depends on unobserved predictors (NMAR): Missingness is no longer “at random” if it depends on information that has not been recorded and this information also predicts the missing values. There are some underlying unobserved factors that could lead people not to answer a given question and they can differ from one person to another. Therefore, the probability of missingness is different across unit in our survey. An example is when during a survey a corrupted person is not going to declare his revenue because he knows that if he declares he can be exposed to pursuit because of corruption (information not recorded) the data will be missing (Allison, 2001; Gelman & Hill, 2006).
- ✓ Missingness that depends on the missing value itself: Finally, a particularly difficult situation arises when the probability of missingness depends on the (potentially missing) variable itself. For example, this often happens because people are unlikely to reveal a high income to avoid being exposed (Allison, 2001; Gelman & Hill, 2006).

All these types of missingness can happen during survey and can be observed in data set

depending on variables and the data collection process. To identify the type of missingness, the final data set ultimate user should be close to the data base constructor or be involved in data collection. The most frequent type of missingness mechanism is MAR. Practically, this is the one which can easily happen.

### **3. Different Imputations methods**

In handling, missing data, we have two possibilities: discard missing data or imputation. Discard some unit presenting missing cases implies to reduce significantly the sample size especially in case more than one variable present missing data at different lines (cases). As a result, the precision of confidence intervals is harmed, statistical power weakens and the parameter estimates may be biased (Soley, 2013). So, the best solution will be to impute data. There are several direct and simple methods of imputation including: Mean imputation (replace missing values by the mean or conditional mean or marginal mean of the variable), Last value carried forward (use the last value from a unit which logically is supposed to be close to the missing one ), Using information from related observations (impute by a value from an individual which is closed to the missing one), Indicator variables for missingness of categorical predictors (add an extra category for the variable indicating missingness.), Indicator variables for missingness of continuous predictors (replace the missing value by a zero or by the mean), Imputation based on logical rules (use the logic of questionnaire to impute a value) (Allison, 2000, 2003).

As we said earlier, our research focuses on comparing any action taken to deal with missing data including discarding cases with missing data. Classical imputation methods are divided into two main groups. Let's assume that our variable of interest with missing observation is  $Y$  and the set of covariates without any missing observation is  $X$ . To simplify notation, forget about the indexes specifying the case. A missing observation in the set is denoted by  $Y_m$  and a non-missing one by  $Y_{nm}$ . Of course, the corresponding covariates will be  $X_m$  and  $X_{nm}$  but it doesn't mean that they are missing.

#### **3.1 Imputation methods that doesn't incorporate random variation**

The main characteristic of these methods is that the missing value is replaced by a single estimator of the true value. They are deterministic methods meaning that there is no randomness in the set of values used for imputation. Running the same method on the same sample will

always produce the same imputed values for unit missing with the same characteristics.

### ***Mean Imputation and Conditional Mean Imputation***

This method can be applied on any type of dataset, with or without covariates. It recommends to replace the missing value by the mean of the missing variable obtained using the non-missing observations. The user can just replace the missing observations in  $Y$  by the marginal mean directly:  $Y_m \square E(Y_{mm})$  or knowing some properties of  $Y$ , conditional mean can also be used. The mean of  $Y$  given certain existing covariates  $X$  in our dataset:  $Y_m = E(Y_{mm} / X = x_m)$ . For example, if among our covariates, there is a variable sex and our variable of interest is determined by sex, we divide our sample into two groups: male and female, then perform mean imputation in each group. It is the most used method even if it leads to biased estimates and low variance and covariances (generally underestimate variances).

### ***Nearest Neighbours Imputation***

To apply this method, a data set with a set of covariates is absolutely needed. The first step of this method is to define what is a neighbour using the set of covariates  $X$ . To define a neighbour, there is a need to define the distance between cases. The default distance is the Euclidian distance:  $d_{ij}^2 = (X_i - X_j)'(X_i - X_j)$ . We can also use the Mahalanobis distance by introducing a transfer matrix in the Euclidian distance. After defining a distance, the user can now decide for a given missing value which case is close to it or not. You can replace the missing observation by the value of the nearest neighbour or by a fixed  $k$  nearest neighbour (averaging) or use a value obtained by all the data set weighting each available case by the inverse of the distance between the missing case and all of them (weighting average). The simulation in this study used the Gower distance developed by Gower (1971) which aggregate all the distances between two points for each variable in one single quantity. The distance was included in the package VIM on R by Kowarik (2016).

### ***Last value carried forward***

This method recommends to use the last value known about the variable for imputation. It means that if we have another survey, collecting the same information a time before the actual survey, from that survey you take information from the same variable and impute to the missing value in the actual data set. This method assumes the value doesn't change much with time. It can be true for some variables like sex but it is not always true.

### ***Regression to perform deterministic Imputation***

The method is a model-based method. It uses econometric (linear regression model or quantile regression for example) to build a model with available cases of  $Y$  and their corresponding covariates. The deterministic part of that model is used to predict the missing values given that all the values of the covariates for each of them are known:  $Y_m \square f(X_{mm})$ . The main advantage of this method is the fact that it uses all information available on different units to predict the missing value and with a good  $R^2$ , imputation can give interesting results. The disadvantages are: it overestimates model fit and correlation estimates and weakens variance of the variable  $Y$ .

### ***Simple random Imputation (Hot deck imputation)***

This method recommends to randomly select a set of available cases among our non-missing observations and impute them to the missing observation or for each missing observation, randomly select another one among the set of observed data and impute,  $Y_m \square \text{Sample}(1, Y_{mm})$ . This method is quite simple and looks interesting but for some database and if you want to perform some specific studies, results can be very bad. It doesn't take into account the covariates if they are available, consequently you can have some atypical case for example a 12-year-old child with a PhD as educational level. This method is suitable if the population is stratified according to some determinant of our variable of interest.

## **3.2 Imputation methods that do incorporate random variation**

This group of methods are characterized by the fact that it allows for randomness in the prediction of missing values. Running this method  $n$  times in a given sample may produce  $n$  different values for a single imputation. Some of the methods presented here can be repeated then the final imputed value will be the average of the different output obtained during repetition.

### ***Regression to perform random Imputation***

This imputation method is almost the same as regression presented in the previous section. It also uses suitable econometric models to build a function of covariates that are going to be used to predict the value of the missing observation. The difference now is the error. After estimation of the coefficients of the regression, we obtain the deterministic part of the model and the error. Knowing the distribution of the error, this method recommends to generate for each predicted value an error and add to the deterministic part to obtain the final predicted value. The result is of the form:  $Y_m \square f(X_{mm}) + \varepsilon_m$ , with  $\varepsilon_m$  following a specific distribution determined by the econometric model. The main advantage here is the fact that the variance of the variable is

preserved due to the randomness of predicted values. The drawback is the same, estimation of coefficient comes with some bias because the coefficient that we are using in the model are not the true coefficients but just estimators which of course brings another bias.

### ***Multiple Imputation (MI)***

Among imputation methods, Multiple imputation is one the most interesting methods and most performant according to literature. The main objective of this method is to replace the full set of missing values by different sets of possible candidates provided (each set) by different methods or by a single method allowing random variation. Multiple Imputation is a simulation procedure and the aim is not to obtain imputed values close enough to the real one but obtain acceptable estimators from the completed dataset (Schafer, 1997).

Multiple imputation involves three main steps:

- a) **For each missing observation, generate  $m$  imputed values to obtain  $m$  completed sets of data.** After identifying which variable has missing values, the user should identify the missingness pattern and then decide which imputation methods to use keeping in mind that each should allow for randomness;
- b) **Analyse the  $m$  set of completed data using standard procedures to produce estimators that we want.** In our case, each completed data set will produce some estimators;
- c) **All the estimators produced from each completed data set are combined to form a single set of final estimates of the parameters of interest.** In this step, the average can be used to obtain the final parameters with a standard deviation and confidence interval.

As advantage, this method can be used with any kind of data and model. It is simulation based therefore any user who is good in programming can perform it in using any software. When data is MAR, Multiple Imputation can lead to consistent, asymptotically efficient, and asymptotically normal estimates. The main drawback is instability of the method. Because of randomness, different users can perform it and obtain totally different results. Even the same user, every time you run the program, you obtain different results hopefully slightly different. In the simulations, the MI method used generates Multivariate Imputations by Chained Equations (MICE). In the MICE procedure, a series of regression models are run whereby each variable with missing data is modeled conditional upon the other variables in the data. This means that each variable can be modeled according to its distribution, with, for example, binary variables modeled using logistic

regression and continuous variables modeled using linear regression.

### **Maximum likelihood Imputation (ML)**

This method is used to obtain the variance-covariance matrix for the variable in the model based on all the available data points, and then use the obtained variance-covariance matrix to estimate the regression model (Schafer, 1997). This method is quite simple if you use an appropriate software, you only need to specify your model of interest and indicate that you want to use ML. Theoretically, the basic idea is as follows. Given a set of data with  $n$  independent observations and  $k+1$  variables  $(y_i, x_{i1}, \dots, x_{ki})$  and assuming that there is no missing data in that set, the likelihood function is given by:

$$L = \prod_{i=1}^n f_i(y_i, x_{i1}, \dots, x_{ki}; \theta) \quad (3.2.1)$$

where  $f_i(\cdot)$  is the joint probability function of  $i$  observations and  $\theta$  the set of parameters to be estimated. The ML estimates are the values of  $\theta$  that maximise  $L$ . Now, in the specific case of this research, suppose that for some observations  $i$ , the first variable  $Y$  has missing data that satisfies MAR assumption of missingness. Now the joint probability of the observed data is given by:

$$f_i^*(x_{i1}, \dots, x_{ki}; \theta) = \int_y f_i(y_i, x_{i1}, \dots, x_{ki}; \theta) dy \quad (3.2.2)$$

For each observation's contribution to the likelihood function, we integrate over the variables that have missing data, obtaining the marginal distribution of observing those variables that have actually been observed.

Considering that there are  $m$  missing observations in the first variable over  $n$ , ordered such that the first  $n-m$  lines are completed and the last  $m$  have missing data, the likelihood function of the full data set becomes

$$L = \prod_{i=1}^{n-m} f_i(y_i, x_{i1}, \dots, x_{ki}; \theta) \prod_{i=n-m+1}^n f_i^*(x_{i1}, \dots, x_{ki}; \theta) \quad (3.2.3)$$

This likelihood function can then be maximized to get ML estimates of  $\theta$  using several different methods.

There are two main ML methods:

- a) **Direct Maximum Likelihood:** implies direct maximization of the multivariate normal likelihood function for the assumed linear model.
- b) **The expectation – Maximization (EM) algorithm:** provides estimates of the mean and covariance matrix which can be used to get consistent estimates of the parameters of interest.

For the simulation, the R package MissMech is chosen. Two options are used to perform ML: firstly, the program assumes that data follow a multivariate normal distribution then secondly no assumption is made on the distribution but a maximization algorithm is used to obtain the covariance matrix.

#### 4. Simulations and Results

This section presents an analysis of performance of different imputation methods on a simulated data set. The aim is to answer the question: which imputation methods gives better results in terms of reconstructing dataset and in terms of leading to better estimates of some statistical quantities for simulated data?

##### 4.1 Simulation protocol

To simplify our analysis, we assume that there is only one variable  $y$  with missing observations in the data set with in the sample of size  $n$ . In addition to that, there are some covariates  $x_1, x_2$  and  $x_3$  generated given specific distributions (continuous and discrete) which determine the variable  $y$ .

Initially, the variables  $y, x_1, x_2$  and  $x_3$  are generated without missing value according to the regression equation  $\hat{y} = \hat{\alpha}_1 x_1 + \hat{\alpha}_2 x_2 + \hat{\alpha}_3 x_3$ . With the data set without missing values (sample size  $n$ ), we compute the true sample value of the mean  $\mu$  of  $y$ , the standard deviation  $\sigma$ , the coefficients  $\alpha_i$  already known, in short the vector  $param = (\mu, \sigma, \alpha_1, \alpha_2)$  is computed. Then, we gradually create missing data in the data set for the variable  $y$  from 10% of missing values up to 60% with a step 10%, 6 different percentages of missing values. For each percentage of missing values generated, firstly the vector  $param$  is estimated using the complete case available (listwise deletion). Secondly, using specific imputation methods, the  $s\%$  missing is estimated and then the vector  $param$  is again estimated in a bootstrap of 1000 replication and compared to the true

value. In addition to *param* in the second step, the RMSE and MAE are computed to see how good the imputation methods were.

### ***Steps of simulation***

- **Step1:**Generate a sample of  $n$  observation of the random vector  $(Y, X_1, X_2, X_3)$  such that there is a linear and significant link between  $Y$  and the  $X$  covariates: output  $(Y_i, X_{1i}, X_{2i}, X_{3i})_{i=1}^n$ .
- **Step 2:** Compute the population or the full sample parameters from the simulated data such that  $param = (\mu = mean(Y), \sigma = std(Y), \alpha_1, \alpha_2)$ ; where  $\alpha_1$  and  $\alpha_2$  are coefficient of  $X_1$  and  $X_2$  in the linear regression  $Y = f(X_1, X_2)$ .
- **Step 3:** Create randomly  $s$  percent of missing value in the vector  $Y$  with  $s \in \{10, 20, 30, 40, 50, 60\}$ , leading to six  $Y$  variables with different percent of missing values.
- **Step 4:** For each percentage of missing value, first compute the vector *param* using complete case analysis meaning cases with missing data are deleted before estimation. Secondly, using each imputation methods selected, impute the missing values and compute the vector *param* and the quantities *RMSE* and *MAE*.
- **Step 5:** Compare the output of the simulation in bootstrap procedure of 1000 replications. Firstly, compare the vector *param* for complete case analysis and for the one obtained in each imputation method to the real value of parameters and for different percentage of missing values (to see which method is best in estimating the true parameters). Secondly, compare *RMSE* and *MAE* for different imputation method and different percentage of missing values (to see which method is best in reconstructing data).

As said in the last step, to make sure that the results are robust and to get standard errors, the simulation is associated with a bootstrap procedure of 1000 replication (creation of  $s$  percent of missing value 1000 times).

## **4.2 Results and discussion**

All the simulations were done with a sample size of 1000 unit and 1000 replication in the

bootstrap (for a given percentage, sampling 1000 times missing values) to see stability of results. Here is summary of results from two points of view: Reconstruction of data and ability to give better estimates of the full sample parameters. The results are specifically for the simulated data that we have, changing parameters of simulation can lead to other results.

#### 4.2.1 Ability to reconstruct the data

The general comment on the results is that the value of RMSE is almost the same for all percentages of missing value for a given imputation method, with a slight increase for higher percentages of missing values. Figure 1 shows that for ML imputation, the RMSE is around 109 for the first 3 percentages of missing values but slightly above 110 for the last 3. This remark is the same for all the 7 RMSE computed. In addition to that, the error observed on RMSE is quite small meaning that the results obtain after simulations are quite stable and are not due to randomness. Comparing now different imputation methods, Figure 1 shows us that the best imputation method in data reconstruction (smallest RMSE) is Mean Imputation no matter the percentage of missing value, with an average RMSE of 100.78, followed by Regression Imputation without randomness with an average RMSE of 101.12 among all the percentage of missing values.

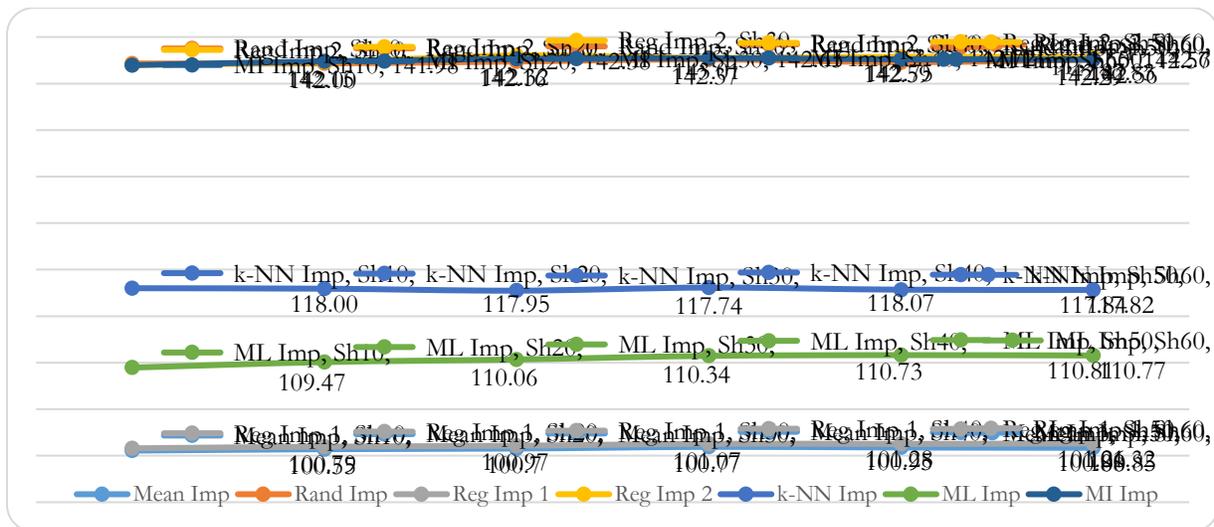
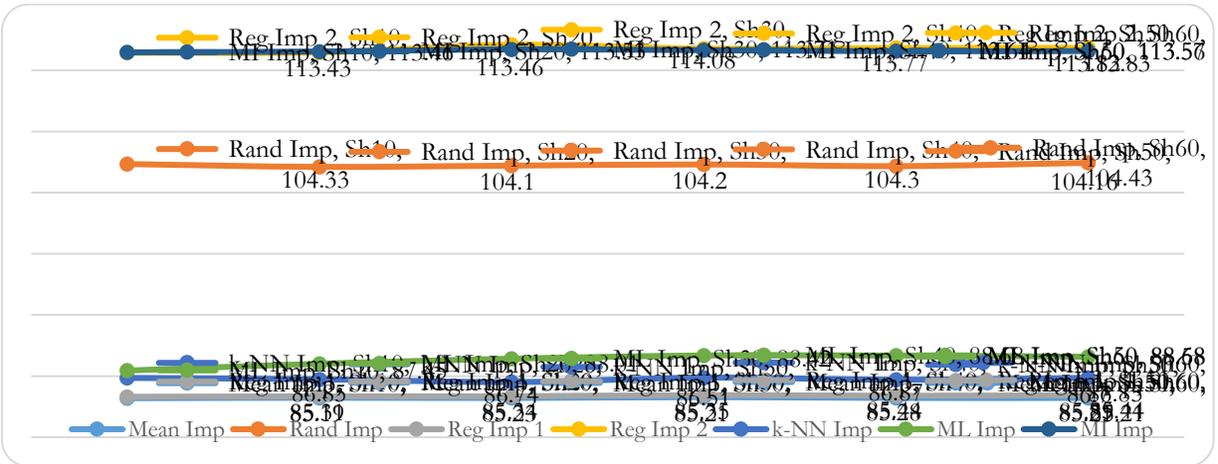


Figure 1: RMSE for imputation methods per percentage of missing value

The methods performing less than the others are Random imputation, Regression imputation with randomness and Random imputation. Their RMSE is above 140 which is clearly above all RMSE

observed.

When we look at the MAE trends in Figure 2, the tendency is the same as for the RMSE. The value is quite constant along the different percentages of missing values but with a slight increase when the percentage increase. The errors are also small meaning a good stability in results.



**Figure 2:** MAE for imputation methods per percentage of missing value

Here again the best imputation method is Mean imputation with an average MAE of 85.22 among all the percentages of missing value tested. The second best is the deterministic Regression Imputation with an average MAE of 85.38. When we look at the methods with the highest MAE, we find that Multiple imputation and Regression imputation with randomness are the one with the bad results.

To sum up, the best methods in data reconstruction are Mean imputation and deterministic Regression imputation. The weaker methods in data reconstruction are Multiple Imputation and Regression with Randomness. It seems like in general, with simulated data (given distribution clearly known) imputation methods including randomness performs less compared to those without randomness.

#### 4.2.2 Ability to estimate full sample parameters

Secondly, the methods are tested on their ability to estimate some statistics computed on the full sample without missing values. As said in the simulation protocol, those statistics are mean, standard deviation and coefficient of a linear regression applied on data.

In summary for the results, if we consider mean as parameter and all the percentage of

missing values, the methods estimating mean with a small bias are Listwise deletion, Mean imputation and Deterministic Regression imputation. The worst is k-NN with the biggest bias no matter the percentage of missing values observed.

Considering the standard deviation as parameter, again here Listwise deletion and Mean imputation are among the best methods in estimation. Close to them, Multiple Imputation can be added as good imputation method to estimate standard deviation. The worst method here is regression imputation without randomness with the biggest bias considering all the percentage of missing values.

For the coefficient of linear regression, the Listwise deletion and Mean imputation are on top of the methods, followed closely by regression imputation. Looking at the worst imputation methods used to estimate the coefficients, k-NN is on top of the list.

### **4.3 General comments and discussions**

The results presented here are results from simulated data using specific distributions, sample size of 1000 and 1000 replications which leads to quite interesting and good results especially with mean imputation and Listwise deletion. These results can change if these parameters are changed. For example, with a bigger sample size or a smaller sample size, the results can change. With 200 as sample size you cannot impute 60% with a risk of changing the nature of initial distribution while with a larger sample size (2000 for example) you can go up to 70 percent if you want depending on the method. This simulation shows that up to 60% of data missing, results are almost the same. Bias is almost the same for all the percentages meaning that it is possible, in certain cases, to impute more than 50 percent of the data when they are missing.

In this work, we found that for imputation methods like regression, the better the  $R^2$  the better will be the imputation results. It is not good to use regression imputation when the covariates explain a few percentage of the dependent variable presenting missing data. Consequence will be a very bad reconstruction of data leading of course to bias in all other estimators.

For some cases, methods like mean imputation can be improved by conditional mean imputation. In case the variable to impute is quite linked or determined by another variable, conditional mean imputation on that other variable is advised. It is the same case for k-NN imputation which in this study did not perform very well because all the variables were generated

randomly without link which is rarely the case in the true data sets.

As we have seen also in this simulation study, the sample size is quite big and we went up to 1000 replication to make sure of the stability of results. With a real data set, the statistician should rely on bootstrap to soften the bias that may occur during imputation. In addition, he/she should go for imputation methods that allows randomness like random regression imputation and multiple imputation.

The main conclusion or output drawn from the simulation section is a process to identify which method is suitable for imputation given a dataset. The process is as follows: use the variable in your dataset with missing data that you want to impute, truncate your data set and use only available cases to run the previous simulation process. This means that in the full matrix of the truncated data set, create missing values in the variable of interest and impute them using different methods. The method that gives you the best results will be used in the initial dataset to impute the values that are really missing. The algorithm to perform the best imputation with a real dataset is as follows:

- **Step 1:** Identify which variable in your dataset (Y) you would like to use imputation on, compute the percentage of missing values (s%) and identify all other variables that are determinant to Y in your data set.
- **Step 2:** Truncate your initial dataset and consider only case with all observations, a kind of complete case analysis. In this secondary data set, perform the simulation explained early in this section with s% of missing data. In other words, in the secondary data set without missing data, create s% of missing data in Y and impute them and compute RMSE and MAE, perform it 1000 times to get standard deviation. The best method is the one that gives smallest values of RMSE and MAE.
- **Step 3:** Using the best method identified in step 2, perform imputation once in the initial dataset of step 1.

The results obtained from this process are surely the best we can get for imputation.

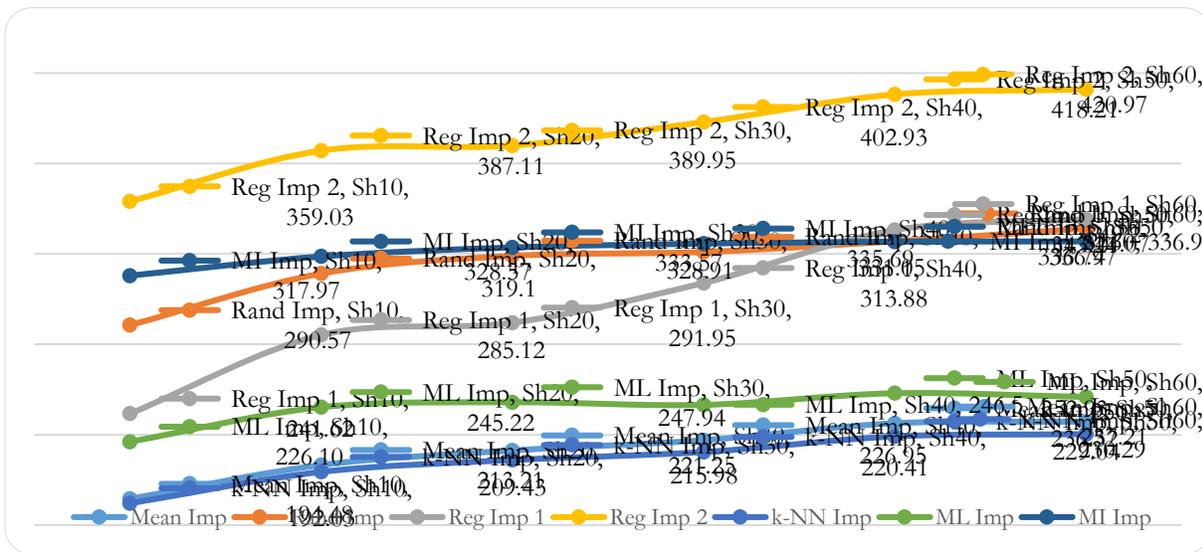
## 5. Applications

After simulations, the output of the analysis is a process to identify which method to use when we have a real data set. This section presents an application of this process. The data used here are from an agricultural household survey in Rwanda on 406 farming household over 4 regions in

Rwanda. The variables of interest here is the Production of beans in Kg during wintering season of the year 2016 – 2017. Among the covariates we have: Use of climate information, Quantity of labour used, Quantity of seeds, Area cultivated, Tropical Livestock Index and Asset index. We applied the process described at the end of the section 4 and the results are summarized below<sup>4</sup>.

### 5.1 Reconstruction of data

As in the simulation section, the reconstruction of data is measured by RMSE and MAE parameters. Figure 3 presents the change in RMSE according to each imputation methods and an increasing percentage of missing values.

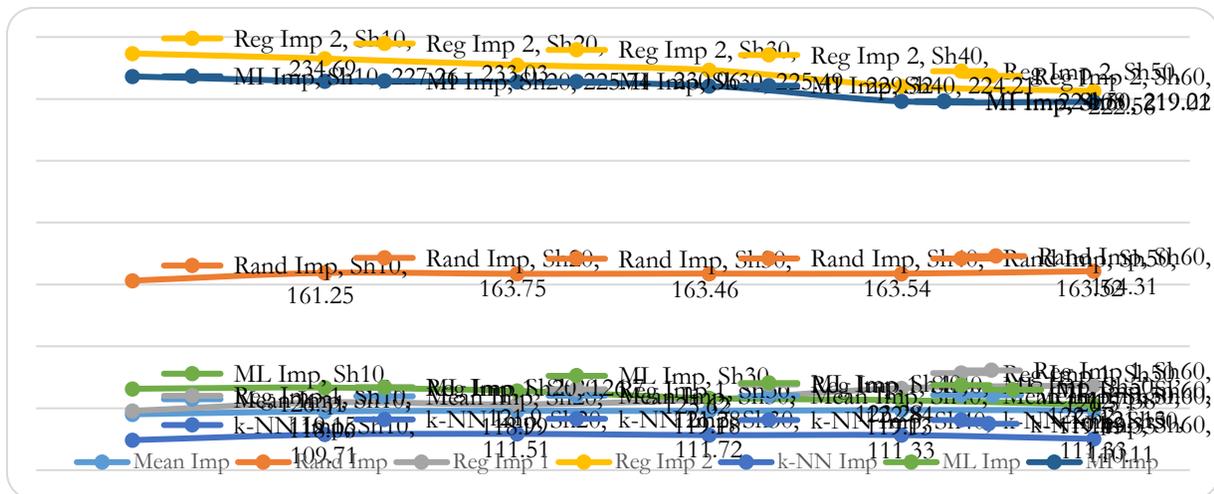


**Figure 3:** RMSE for imputation methods on real data of Rwanda

It is clear that for all the imputation methods, the RMSE increase with the percentage of missing values and the best method in reconstructing data is k-NN for this given data set. The second best is Mean imputation and the worst method is regression imputation with randomness.

If we look at the second indicator of goodness-of-fit in reconstruction in figure 4, the MAE is quite stable with the increasing percentage of missing value and it decrease even for Regression imputation and Multiple Imputation.

<sup>4</sup>See appendices section for full results



**Figure 4:** MAE for imputation methods on real data of Rwanda

Here again the best method in data reconstruction is k-NN and the second best is mean imputation. The worst methods are Random regression imputation and Multiple imputation. The conclusion here is that for this given dataset, in case imputations have to be made to reconstruct the data, the suitable methods are k-NN applied very well and Mean imputation.

## 5.2 Estimators of some statistics

If we look at the statistics estimated by the complete case analysis and the imputed dataset for each method on our variable of interest, the following conclusions can be drawn:

- ✓ In estimating the mean with the smallest bias, Listwise deletion, mean imputation and MI imputation are the three best imputation methods;
- ✓ In estimating standard deviation with the smallest bias, Listwise deletion, Multiple imputation and Regression imputation are the best three methods;
- ✓ In estimating coefficients of the linear regression, Regression imputation deterministic and random are the best methods.

Depending on what exactly you want to generate with your data, some methods are better than others. In absolute necessity of imputation, Multiple imputation will be the best one in estimating specific statistics with this dataset.

## 6. Conclusion

The aim of this study was to analyse the performance of imputation methods in case of

simulated data and in case of real data. Finally, the main result obtained is that the performance of Imputation methods is closely link to the parameters of simulation and to the structure of data. Thus, an absolute decision cannot be taken. A major result here is that using bootstrap, the percentage of missing data in the variable doesn't matter much. We imputed up to 60% of missing data with quite good results in this study both in simulated and real dataset.

Practically, this study is more about explaining the process required to calibrate and identify which method will give better results during imputations in case data are missing completely at random. It cannot be used to compare imputation methods and conclude. In fact, as we have seen in simulations and applications, the methods performing very well are different depending on the simulation parameters and on the structure of the data when data are simulated. Even in case of real data, performance can change according to the profile of data (what are the different distributions concerned? are we having extreme values? Atypical values?). This study shows essentially in a case of missing data in a dataset, how to calibrate and choose which method will give you the best results.

More example of simulation and data set can be done using the simulation protocol developed here. There are many other imputation methods that can be tested. Given that bootstrap is used and 60% of data can be estimated using the methods tested in this work, imputation methods can be used beyond simple missing data estimation but also for censored data to estimate counterfactual in the framework of impact evaluation.

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## Appendices

### Imputation results on Rwandan Data using the same protocol as the one in section 4

(Results of simulation section are almost the same form)

RMSE	MAE	Mu	Std Dev	Coef 1	Coef 2
		167,8	245,9	71,5	0,34

**Share: 10% of data are missing.**

RMSE		MAE		Mu		Stand Dev		Coef1		Coef2		Bias		
Val	Er	Val	Er	Val	Er	Val	Er	Val	Er	Val	Er	Mu	StDev	C
0,00	0,00	0,00	0,00	167,96	3,86	244,86	28,82	119,03	18,15	0,69	0,64	0,16	-1,04	4
194,48	141,29	118,06	29,76	167,96	3,86	232,14	27,32	122,83	5,75	0,49	0,06	0,16	-13,76	5
290,57	170,62	161,25	43,60	167,92	5,42	243,31	34,64	122,81	8,33	0,49	0,07	0,12	-2,59	5
241,62	214,88	119,15	44,95	168,95	5,37	242,15	42,26	119,04	17,91	0,69	0,63	1,15	-3,75	4
359,03	173,90	234,69	40,05	168,95	6,47	253,39	42,42	118,76	19,39	0,69	0,63	1,15	7,49	4
192,03	131,75	109,71	29,97	165,04	3,52	233,94	27,03	121,76	5,67	0,49	0,06	-2,76	-11,96	5
226,10	133,36	126,31	32,37	168,56	4,22	237,18	28,63	122,18	8,09	0,52	0,17	0,76	-8,72	5
317,97	104,34	227,26	27,87	167,91	5,23	244,95	28,98	122,18	8,09	0,52	0,17	0,11	-0,95	5

**Share: 20% of data are missing.**

RMSE		MAE		Mu		Stand Dev		Coef1		Coef2		Bias		
Val	Er	Val	Er	Val	Er	Val	Er	Val	Er	Val	Er	Mu	StDev	C
0,00	0,00	0,00	0,00	167,80	6,10	242,04	43,63	112,92	26,88	0,90	0,95	0,00	-3,86	4
213,21	122,99	118,99	19,62	167,80	6,10	216,49	39,03	121,90	7,87	0,46	0,09	0	-29,41	5
319,10	139,82	163,75	30,76	167,76	8,43	240,29	51,82	122,18	12,50	0,46	0,09	-0,04	-5,61	5
285,12	199,86	121,90	33,39	170,04	8,60	240,78	70,03	112,83	27,30	0,91	0,97	2,24	-5,12	4
387,11	154,65	233,03	31,94	170,14	10,18	261,80	69,83	112,69	28,70	0,91	0,97	2,34	15,9	4
209,43	115,28	111,51	20,78	162,04	5,09	220,40	38,15	119,50	7,59	0,46	0,08	-5,76	-25,5	4
245,22	107,53	126,70	21,05	168,70	6,60	226,66	41,96	121,28	10,92	0,54	0,26	0,9	-19,24	4
328,57	72,05	225,74	21,16	167,74	7,61	241,84	43,75	121,28	10,92	0,54	0,26	-0,06	-4,06	4

**Share: 30% of data are missing.**

RMSE		MAE		Mu		Stand Dev		Coef1		Coef2					
Val	Er	Val	Er	Val	Er	Val	Er	Val	Er	Val	Er				
0,00	0,00	0,00	0,00	167,83	7,96	240,27	55,43	109,53	31,48	1,02	1,10		0,03	-5,63	3
221,25	104,71	119,18	13,96	167,83	7,96	200,84	46,34	120,91	9,68	0,44	0,10		0,03	-45,06	4
328,91	111,22	163,46	23,14	167,77	10,53	237,99	64,35	120,75	14,85	0,44	0,12		-0,03	-7,91	4
291,95	177,03	121,28	26,63	170,64	10,74	235,51	88,31	109,44	32,47	1,02	1,15		2,84	-10,39	3
389,95	133,12	230,96	33,13	170,46	12,21	267,17	87,97	109,80	35,04	1,02	1,15		2,66	21,27	3
215,98	98,22	111,72	15,78	158,67	6,25	207,01	44,85	116,31	9,86	0,44	0,10		-9,13	-38,89	4
247,94	85,56	125,62	14,76	168,35	8,65	215,06	50,14	121,02	13,71	0,52	0,29		0,55	-30,84	4
333,57	45,67	225,49	28,35	167,79	9,97	240,17	55,59	121,02	13,71	0,52	0,29		-0,01	-5,73	4

Share: 40% of data are missing.

RMSE		MAE		Mu		Stand Dev		Coef1		Coef2					
Val	Er	Val	Er	Val	Er	Val	Er	Val	Er	Val	Er				
0,00	0,00	0,00	0,00	167,81	9,88	238,00	66,98	103,41	37,60	1,23	1,33		0,01	-7,9	3
226,95	90,66	119,13	10,34	167,81	9,88	184,36	51,88	120,07	10,77	0,42	0,11		0,01	-61,54	4
331,05	90,10	163,54	18,93	167,59	12,51	233,37	73,91	119,28	16,28	0,42	0,14		-0,21	-12,53	4
313,88	177,77	122,84	24,86	172,05	13,69	237,91	116,76	102,99	40,04	1,25	1,44		4,25	-7,99	3
402,93	140,35	229,32	40,37	172,09	15,22	278,33	115,33	103,16	41,40	1,25	1,44		4,29	32,43	3
220,41	85,59	111,33	12,87	155,18	7,09	193,04	49,60	113,54	11,15	0,41	0,10		-12,62	-52,86	4
246,50	72,99	123,28	12,71	167,75	10,42	202,11	56,29	120,67	15,71	0,51	0,31		-0,05	-43,79	4
335,69	26,26	224,21	36,82	167,90	12,13	237,95	67,18	120,67	15,71	0,51	0,31		0,1	-7,95	4

Share: 50% of data are missing.

RMSE		MAE		Mu		Stand Dev		Coef1		Coef2					
Val	Er	Val	Er	Val	Er	Val	Er	Val	Er	Val	Er				
0,00	0,00	0,00	0,00	167,54	12,07	230,19	79,20	93,88	43,02	1,52	1,59		-0,26	-15,71	2
236,32	78,24	119,43	7,12	167,54	12,07	162,57	55,94	118,41	12,39	0,38	0,12		-0,26	-83,33	4
336,97	71,12	163,52	15,00	167,38	14,54	225,19	83,98	117,76	18,78	0,38	0,14		-0,42	-20,71	4
343,21	187,84	126,50	26,30	173,92	17,73	244,42	152,60	92,91	47,42	1,55	1,79		6,12	-1,48	2
418,21	160,00	224,08	49,74	173,99	19,47	290,61	149,03	93,28	48,48	1,55	1,79		6,19	44,71	2

229,04	74,42	111,33	10,49	151,16	7,97	174,36	52,82	109,51	13,14	0,38	0,11		-16,64	-71,54	3
252,93	57,99	122,62	10,56	166,76	11,98	185,81	62,28	118,37	18,19	0,51	0,34		-1,04	-60,09	4
336,74	13,92	219,21	46,87	168,11	14,28	229,93	79,78	118,37	18,19	0,51	0,34		0,31	-15,97	4

Share: 60% of data are missing.

RMSE		MAE		Mu		Stand Dev		Coef1		Coef2					
Val	Er	Val	Er	Val	Er	Val	Er	Val	Er	Val	Er				
0,00	0,00	0,00	0,00	168,07	15,41	229,00	91,73	88,13	49,27	1,75	1,76		0,27	-16,9	1
237,21	65,94	119,33	4,60	168,07	15,41	144,38	57,84	118,48	14,25	0,36	0,12		0,27	-	4
344,07	65,84	164,31	14,83	167,91	18,07	226,76	99,14	118,26	21,92	0,36	0,13		0,11	-19,14	4
349,20	192,31	127,38	27,47	175,76	21,45	249,22	177,66	87,56	54,68	1,77	2,01		7,96	3,32	1
420,97	171,92	222,56	58,43	175,49	22,76	303,77	173,69	87,46	56,96	1,76	2,01		7,69	57,87	1
230,29	64,06	110,11	8,93	146,63	9,41	159,20	53,95	106,30	15,17	0,35	0,11		-21,17	-86,7	3
250,87	46,79	121,13	9,65	165,78	14,68	172,86	65,37	118,71	22,78	0,48	0,35		-2,02	-73,04	4
336,90	25,30	219,02	57,07	168,13	17,77	229,02	92,12	118,71	22,78	0,48	0,35		0,33	-16,88	4

# **Hiv/Aids Epidemical Analysis and Modelling the Impact of Public Health Education Campaign on the Transmission Dynamics of Hiv/Aids**

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## **ABSTRACT**

The most important factor in the management and control of an infectious disease is the understanding of the dynamics of the disease in any given population. We have proposed and analyzed a nonlinear mathematical model for the spread of HIV/AIDS in a population with variable size structure. The model was developed by adopting the compartmental modeling approach where the population was partitioned into; Susceptible, Infected and Aids sub-populations. A threshold parameter is found that completely determines the stability dynamics and outcome of the disease. It is found that if the threshold parameter is less than one the disease free equilibrium is stable and the disease dies out. However, if the threshold parameter is more than one, there exists a unique endemic equilibrium that is locally asymptotically stable. Numerical simulation of the model is also performed by using fourth order Runge - Kutta method. Numerically, it has been found that the system exhibits steady state bifurcation for some parameter values. It is concluded from our analysis that public health education is more efficient if the susceptible individuals are educated in time and followed up by treatment in the exposed sub-population.

## **KEYWORDS**

Jacobian matrix, population, Education, Basic reproduction ratio- $R_0$ , Compartmental model, Susceptible, exposed, infective, educated, basic reproduction ratio, persistence, steady state equilibrium, bifurcation, Disease-free Equilibrium, Mathematical modeling.

## **1. Introduction**

HIV/AIDS is a serious and highly infectious disease which may lead to hospitalization or death. Epidemiology is the study of the distribution and determinants of diseases, for both infectious and non-infectious diseases. Originally, the term was used to refer only to the study of epidemic infection diseases, but it is now applied more broadly to other diseases as well. Mathematical models have become important tools in analyzing the spread and control of infectious diseases. The model formulation clarifies assumptions, variables and parameters.

Moreover models provide conceptual results such as thresholds, basic reproduction numbers, contact numbers and replacement numbers. Understanding the transmission characteristics of infectious diseases in communities, regions and countries can lead to better approaches to decreasing the transmission of these diseases. As explained in, mathematical models are used in comparing, planning, implementing, evaluating and optimizing various detection, prevention, therapy and control programs. We introduce the following definitions and theorems necessary to model the population dynamics of HIV/AIDS.

Since its emergence in the 1980s, the human immunodeficiency virus (HIV), and the associated syndrome of opportunistic infections which lead to the late stage HIV disease, known as the acquired immunodeficiency syndrome (AIDS), continue to be one of the most serious global public health menaces. Global and regional estimates of HIV have been provided by the Joint United Nations Programme on HIV/AIDS (UNAIDS) and the World Health Organization (WHO) since the late 1980s and country specific estimates since 1996 UNAIDS, 2009; Garcia-Calleja *et al.*, (2006). Unlike the early years of AIDS epidemic where the majority of infected individuals were homosexuals, hemophiliacs, and intravenous drug users, today there is no geographical area, class and cultural group of the world untouched by this pandemic Koob and Harvan, (2003).

Based on the current trends, over 7300 persons become infected with HIV, 5400 die from AIDS-related causes including more than 760 children, every day UNAIDS, (2009). In other words, almost five people become infected with HIV and four people (i.e., three adults and one child) die from AIDS per minute UNAIDS, (2009) .With an estimated adult HIV prevalence of 26% in 2007, Swaziland has the most severe level of infection in the world UNAIDS, (2008).

The recent statistics have shown that an estimate of 22.4 million [20.8 million - 24.1 million] people (women account for approximately 60%) living with HIV in sub-Saharan Africa at the end of 2008 UNAIDS, (2009); Garcia-Calleja *et al.* (2006). Moreover, 72% of world's AIDS-related deaths, 68% of new HIV infections among adults and 91% of new HIV infections among children occurred in sub-Saharan Africa UNAIDS, (2009).

In addition, the epidemic has left behind more than 14 million AIDS orphans in the region in 2008. Once HIV has entered the body, its major target is a class of lymphocytes, or white blood cells, known as  $CD_4^+$  T cells. Thus, the immune system initiates anti-HIV antibody and

cytotoxic T cell production. However, it can take two to ten weeks for an individual exposed to HIV to produce measurable quantities of antibody. Because of the central role of CD<sub>4</sub><sup>+</sup> T cells in immune regulation, their depletion has widespread deleterious effects on the functioning of the immune system as a whole and leads to the immunodeficiency that characterizes AIDS.

Therefore, HIV levels in the bloodstream are typically highest when a person is first infected and again in the late stages of the illness. The progression of HIV infection to AIDS probably depends on how well the body can replace cells destroyed by virus Perelson and Nelson, (1999). Modes of HIV transmission Epidemiological evidence shows that HIV is transmitted only through the intimate exchange of body fluids, such as blood, semen, vaginal secretion, and mother's milk Dane and Miller, (1990). Thus, HIV could be passed from an infected mother to her child (i.e., vertical infection) during pregnancy, birth or through infected breast milk.

High-risk behaviors include unprotected sexual intercourse and intravenous drug use through sharing needles or syringes. The viral load against HIV is depicted. The early peak in viral load corresponds to primary infection. Primary infection is followed by a long asymptomatic period during which the viral load changes little. Ultimately, the viral load increases and the symptoms of full-blown AIDS appear. On average, the time from infection to AIDS is 10 years, but still some patient's progress to AIDS much more rapidly, while others progress more slowly.

## **2. Related works/Literature survey**

HIV is classified as an infectious disease which rapidly spreads amongst communities and changes its distributions in space, time and social space Wallace, (1991), Daniel S.L. (2003). Many factors, including increased mobility, are associated with an increased risk of HIV infection Welz *et al.*, (2007), Altmann. M (1995), Brauer F(2001). The transmission of HIV is also strongly associated with the spatial distribution of high risk groups. The distribution of AIDS cases not only varies by cities and states, but also by geographical regions Lange *et al.*, (1988).

The models that are labeled by SI, SIS, SEIS, and SEIR are mostly used where the sub-populations are Susceptible, Exposed, Infected and Recovered or Removed.

Nyabadza *et al* (2010) ,Castillo-Chavez *et al* (1989),looked at a model of HIV/AIDS that examine the diminution in infection by promoting a change in sexual behavior through public health information campaigns and individuals with AIDS to abstain from sexual activities. Both the endemic and disease free equilibrium have been investigated. Numerical simulations are presented using the fourth order of Runge-Kutta. The results from their research have shown that media campaigns had led to a reduction in the prevalence of the disease but may not be the only ultimate strategy in the fight against HIV/AIDS. It has also shown that an increase in the distribution of public health information campaigns has led to a decrease in occurrence of a disease. In the case of the individual with AIDS abstaining from sexual activities, it has also reduced the effect of the disease.

The impact of educational campaigns as a control measure for the spread of HIV/AIDS has been investigated by Mukandavire *et al* (2009),Elbasha and Gumel A.B. (2006). The authors present a sexual transmission model with explicit incubation period. Their results suggested that educating sexually immature and sexually mature individuals concurrently is more effective in slowing down HIV/AIDS than concentrating on cohort public health educational campaign of sexually immature or sexually mature individuals only. It is shown that in their study, in situations where education is effective and with reasonable average number of HIV infected partners, public health campaigns can slow down the epidemic.

An epidemic HIV/AIDS model with treatment has been investigated in the research paper by Cai *et al* (2009). The model allows some infected individuals to move from symptomatic phase to the asymptomatic phase by all kinds of treatments. The authors introduced the time delay to the model in order to investigate the effect of the time delay on the stability of the endemically infected equilibrium. This discrete time delay has also been used to the model to describe the time from the start of the treatment in the symptomatic stage until the treatment effects becomes clear. It was found that treatment can be used to make the disease free equilibrium ( $E_0$ ) stable when it would be unstable in the absence of treatment. On the other hand using the time delay can induce oscillation in the system. Biologically, this means that there is a critical value for the treatment-induced delay which determines the stability of the infected equilibrium  $E^*$ . That is, the infected equilibrium  $E^*$  is asymptotically stable when antiretroviral drugs on average show positive effects in patients within less than time delay.

A continuous model for HIV/AIDS disease progression has been formulated and physiological interpretations were provided by Ida *et al* (2007),Elbasha and Gumel A.B.

(2006). The abstract theory was then applied to show existence of unique solutions to the continuous model describing the behavior of the HIV virus in the human body and its reaction to treatment by antiretroviral therapy. The product formula has suggested appropriate discrete models describing the dynamics of host pathogen interactions with HIV1 and is applied to perform numerical simulations based on the model of the HIV infection process and disease progression. Finally, the results of the numerical simulations are visualized and it was observed that they agreed with medical and physiological aspects.

A simple deterministic HIV/AIDS model incorporating condom use, sexual partner acquisition, behavior change and treatment as HIV/AIDS control strategies has been formulated by Nyabadza *et al* (2011) using a system of ordinary differential equations with the object of applying it to the current South African situation. The authors fit the model to a data from UNAIDS/WHO on HIV/AIDS (2008), LaSalle (1976), in South Africa and the epidemiological facts sheets shows the current prevalence scenario. The results compare very well with other research outcomes on the HIV/AIDS epidemic in South Africa. Projections were made to track the changes in the number of individuals who were able to be under treatment, an important group as far as public health planning is concerned.

Nyabadza and Mukandavire (2011) ,Garcia-Calleja ,formulated a deterministic HIV/AIDS model that incorporates condom use, screening through HIV counseling and testing (HCT). A regular testing and treatment as control strategies has been proposed with the objective of quantifying the effectiveness of HCT in preventing new infections and predicting the long-term dynamics of the epidemic. The authors fit the model to a current prevalence data in South Africa from UNAIDS/WHO reports and epidemiological fact sheet. They looked at a recently launched HTC campaign to model its possible impact on the dynamics of the disease. The model shows that HTC alone has a very little impact in reducing the prevalence of HIV unless the ability of the campaign exceeds an evaluated threshold in the absence of bifurcation. The result has shown that force of infection can only be reduced through behavior change, condom use and reduction in the number of sexual partners and these form the pillars of prevention of new infection. The results have shown that the presence of bifurcation has an important implication in the control of HIV/AIDS. The model has shown that it cannot be eliminated by simply reducing the value of reproduction number  $R_0$  to below unity.

Bhunu *et al* (2009) have considered a more robust systematic and complete qualitative

analysis of a two strain HIV/AIDS model with treatment of AIDS patients. The treatment with amelioration results in an increase in number of HIV patient and a decrease in Aids patients. Bhunu *et al* (2009) have advised that treatment with amelioration should always be accompanied by public health education. The authors investigated that if the drugs used for therapy are 100 percent effective and a positive change in the sexual behavior of treated individuals is achieved, treatment with amelioration will not increase the development of HIV/AIDS in societies but will help communities by lengthening the lives of the infected, thus, reducing morbidity/mortality and socio-economic costs. Further the analysis of the reproduction numbers show that the use of antiretroviral therapy to improve the quality of life of AIDS patients with antiretroviral sensitive, HIV results in an increase of antiretroviral resistant HIV cases supporting the argument that antiretroviral resistance develops as a result of selective pressure on non-resistant strains due to antiretroviral use.

A non-linear mathematical model has been proposed and analyzed to study the spread of HIV/AIDS with direct inflow of infective in a population with inconsistent volume structure. Naresh *et al* (2008) has looked at a model without inflow of HIV infective including interaction with pre-AIDS individuals and Model without inflow of HIV infective and no interaction with pre-AIDS individuals. It was found that if the direct inflow of the infective has been allowed in the community the disease always persist. The endemicity is extensively reduced if direct inflow of infective is restricted and pre-Aids individuals do not take place in sexual activities. Karen and Susan C.W. (1999)., Naresh *et al* (2008) suggested sexual partners should be restricted and unsafe sexual iteration should be avoided with an infective in order to reduce the spread of the disease. Thus the spread of infection can be slowed down if direct inflow of infectives is restricted into the population. It was also noted that the increase in the number of sexual partners further reduces the total population by way of spreading the disease. Thus in order to reduce the spread of the disease, the number of sexual partners should be restricted and unsafe sexual interaction should be avoided with an infective.

Zurakowskia A.R. Teel (2006),Lange, F.R., *et al* (1988), has proposed the interaction of the immune system and human immunodeficiency virus where we will introduce the possibility of using highly active anti-retroviral therapy (HAART) to stimulate the vaccine. They further present a model predictive control (MPC) based method for determining optimal treatment. Finally they analyze the simulations by using algorithms where they apply robustness

measurement noise, robustness modeling error, robustness combined errors, and varying the cost function. An SIR model with six compartments where there is an interaction between HIV and TB epidemics has been investigated. They further look at sensitivity of the steady states with respect to changes in parameter values. The authors examine that most of the control measures studied have an obvious positive impact in controlling the HIV or TB epidemics, this is the case for condom use, increased TB detection and preventive treatment. The situation for ART is more complicated. However, although the future for the prevalence of HIV is uncertain, it seems that a generalized access to ART would lead to a significant decrease of the TB notification rate. They further concluded that it is difficult to guess if the observations drawn from the model with parameters adapted to the particular South African township are still valid for less crowded areas with high HIV prevalence, finally reliable data on both HIV and TB are still rare.

Mukandavire and Garira (2007) formulated and analyzed a sex-structured model for heterosexual transmission of HIV/AIDS. The model has been further divided into two classes, consisting of individuals involved in high-risk sexual activities and individuals involved in low-risk sexual activities. The model is described as the movement of individuals from high to low sexual activity group as a result of public health education campaigns. The threshold parameter which is the basic reproduction number has been obtained and their stability (local and global) of the disease free equilibrium. The model has been extended to incorporate sex workers, and their role in the spread of HIV/AIDS in settings with heterosexual transmission was explored. In order to assess the possible community benefits of public health educational campaigns in controlling HIV/AIDS comprehensive analytic and numerical techniques were employed.

Mukandavire and Garira (2011) concluded that the presence of sex workers enlarges the epidemic threshold  $R_0$ , thus fuels the epidemic among the heterosexuals, and that public health educational campaigns among the high risk heterosexual population reduces  $R_0$ , thus can help slow or eradicate the epidemic. The models mentioned so far are deterministic and they do not consider the stochastic disturbance of environment which exists in fact. When the environmental noise is not taken into account, an ordinary differential equation is used for AIDS transmission for instance. The introduction of stochastic modeling has provided new insights into the population dynamics of the disease. In particular, stochastic modeling of HIV/AIDS can be found by Ding *et al* (2011) and Jiang *et al* (2010)

In the papers of Lahrouz *et al* (2009) and Garba and Gumel A.B. (2010), they have formulated an SIRS epidemic model with saturated incidence rate and disease-inflicted mortality. In the same paper, the authors have further looked at the stochastic version. The global existence and positivity of the solution of the stochastic system has been established. Under suitable conditions on the intensity of the white noise perturbation, the global stability in probability and  $P^{th}$  moment of the system has been proved. In this regard, this dissertation refers mainly to the papers.

Standard mathematical models of the spread of infectious diseases are well known and have been widely applied for many diseases including HIV in different regions in the world Anderson and May, (1991). There is still no cure or vaccine for HIV, and anti-retroviral drugs (ARVs) are still not widely accessible, particularly in the resource-poor nations (which suffer the vast majority of the HIV burden globally). Yet, HIV remains preventable through the avoidance of high-risk behaviors, such as unprotected sexual intercourse and sharing of drug injection needles.

Moreover, education, as a sole anti-HIV intervention strategy, may not be sufficient to motivate behaviour change Berker and Joseph, (1988). Studies show that public health education increases self-efficacy, which is a determinant for controlling risky behaviour Lindan *et al* (1991). Furthermore, the benefits of new methods of HIV prevention could be jeopardized if they are not accompanied by positive efforts to change risky behaviour. This is in line with the well-known fact that sexual education and awareness of the risk and life-threatening consequences of AIDS can lower the incidence rate in HIV infection Valesco-Hernandez and Hsieh, (1994) and Wang (2006).

Public health education campaigns have been successfully implemented in numerous countries and communities, such as: Uganda, Thailand, Zambia and the US gay community Daniel and Rand, (2003); De Walque, (2007). Between 1991-1998, HIV prevalence dramatically declined in Uganda from 21% to 9.8% (with a corresponding reduction in non-regular sexual partners by 65% coupled with greater levels of awareness about HIV/AIDS; Daniel and Rand (2003).

### **3. STATEMENT OF THE PROBLEM**

HIV/AIDS pandemic in a population continues to be a major public health menace more specifically in developing countries like Kenya. There is still no cure or vaccine for HIV, and

anti-retroviral drugs (ARVs) are still not widely accessible, particularly in the resource-poor nations (which suffer the vast majority of the HIV burden globally). The emergence of drug-resistant HIV strain in the last two decades has been a major problem in tackling this scourge. A mathematical model for investigating the impact of that role of public health education campaign on the transmission dynamics of HIV/AIDS is developed. The purpose of this study is to extend some of the aforementioned studies, by designing and analyzing a new comprehensive model, for HIV transmission in a population, that incorporates the role of public health education campaign and using the model to evaluate the impact of some targeted public health education strategies.

#### **4. MOTIVATION OF THIS RESEARCH**

The motivations of this research are to:

- a) Assess various biological factors such as incubation that are affecting the spread of HIV/AIDS
- b) Model the transmission dynamics of HIV/AIDS for Computational mathematical researchers.
- c) Optimize a model for reducing HIV/AIDS cases in Kenya since it is a developing country without increasing public spending.
- d) Study the magnitude of public protection since it greatly influences the total number of cases avoided and the value of public treatment cost savings.

#### **5. RESEARCH OBJECTIVES**

##### **5.1.GENERAL OBJECTIVES**

It is possible to mathematically model the progress of an infectious disease in order to discover the likely outcome of an epidemic or to help manage it by different control programs.

##### **5.1.1. SPECIFIC OBJECTIVES**

The objectives of this research are to:

- a) Propose a mathematical model for the HIV/AIDS on transmission dynamics.
- b) Assess the impact of HIV/AIDS in Kenya.
- c) Validate the effect of HIV/AIDS model with data from Kenya.

## **6. CONTRIBUTIONS OF THIS ARTICLE ARE:**

- a) Change the perception that mathematical models for the HIV/AIDS which were considered merely speculative and imprecise, but in this study, with the inclusion of explicit elements of biology and behavior in the models, it is possible that they lead to a deeper understanding of the future spread of disease.
- b) Bring to the attention of other researchers that even though the actual data needed for the models might not be accurate or even available, this modeling is still vital in investigating how changes in the various assumptions and parameter values affect the course of the epidemic. Mathematical modeling helps in the set of conditions by which the extinction of susceptible population is reached.
- c) Show that the improvements in data capture produce major challenges in developing frameworks capable of utilizing this data to predict the complex patterns of evolution of infectious diseases in increasingly dense and interconnected human populations. This mathematical model and its computer simulation is useful in analyzing the spread and control of HIV/AIDS as a killer disease.

## **7. Assumptions of the model**

- (i) At the beginning of the epidemic, at  $t = 0$ , that  $S(0)$  a large population, that  $I(0)$  is very small and that  $A(0) = 0$ .
- (ii) The AIDS patients who received public health education die due to AIDS at a slower rate than the AIDS patients who did not.

- (iii) Public health education will be offered to all infected individuals except for the education of high-risk people with AIDS and hence will not only be restricted to susceptible individuals.
- (iv) Intensive public health education of newly-recruited sexually-active individuals will be carried out.

## 8. METHODOLOGY

Mathematical models have been used for centuries to develop a better understanding of systems in order to control or optimize results. A wide range of applications include everything from radar development to production rates within factories to the spread of disease.

*Epidemic models* are mathematical models concerned with the spread of infectious diseases. Models are created to study treatment and infection rates in order to optimize our ability to predict quarantine and control disease.

We assume that all parameters in the model are nonnegative and that  $b > 0; d_i > 0; i = 1; 2; 3; 4$ :

### 8.1.GOVERNING EQUATIONS

In this section the governing equations of the model will be discussed in detail. The model takes the form of the following deterministic system of nonlinear differential equations: Gao *et al* (2013) model

$$\begin{aligned} \frac{dS_u}{dt} &= \varphi(1 - P) - \xi S_u - [\lambda_u + (1 - k)\lambda_e] S_u - \mu S_u \\ \frac{dS_e}{dt} &= \varphi P + \xi S_u - (1 - \epsilon) [\lambda_u + (1 - k)\lambda_e] S_e - \mu S_e \\ \frac{dI_u}{dt} &= [\lambda_u + (1 - k)\lambda_e] S_u - \sigma_u I_u - \mu I_u - \psi_1 I_u \\ \frac{dA_u}{dt} &= \sigma_u I_u - \psi_1 A_u - \mu A_u - \delta_u A_u \\ \frac{dI_e}{dt} &= (1 - \epsilon) [\lambda_u + (1 - k)\lambda_e] S_e + \psi_1 I_u - \sigma_e I_e - \mu I_e \\ \frac{dA_e}{dt} &= \sigma_e I_e + \psi_2 A_u - \mu A_e - \delta_e A_e \end{aligned}$$

Where,

$$\lambda_u = \frac{\beta(\lambda_u + \eta_u A_u)}{N} \quad \text{and} \quad \lambda_e = \frac{\beta(\lambda_e + \eta_e A_e)}{N}$$

The rates  $\lambda_u$  and  $\lambda_e$  above are the forces of infection associated with HIV transmission by uneducated (at the rate  $\lambda_u$ ) and educated (at the rate  $\lambda_e$ ) infected individuals, respectively. The

parameter  $\beta$  is the effective contact rate (that is, contact that may result in HIV infection), while the parameters  $\lambda_u > \lambda_e > 1$  account for the relative infectiousness of individuals with AIDS symptoms in comparison to the corresponding infected individuals with no AIDS symptoms.

It will be investigated about the manner in which the educated infected individuals (in  $I_u$  or  $A_u$  class) modify their behaviour positively in order to reduce their risk of HIV transmission by a factor  $k$ , with  $0 < k < 1$ .

This model is to help in the understanding of the disease by; allowing for HIV transmission by the individuals with AIDS symptoms, offering public health education to all infected individuals which will only be restricted to susceptible individuals and stratifying the infected population in terms of whether or not they received public health education

In addition to the aforementioned extensions, this study will contribute to the literature by giving detailed qualitative analysis of the model.

## 8.2. Positivity and Boundedness of Solutions

Positivity of Solutions Model above describes a human population, and, therefore it is very important to prove that all quantities (susceptible, infected and those with AIDS symptoms population) will be positive for all times. Positivity implies that the system persists i.e. the population survives. From the model system, we note that

All education-related parameters and variables are set to zero in order to understand the dynamical behaviour of education-free sub-model without education. By setting  $A_e = \sigma_e = I_e = k = P = \xi = \psi_1 = \psi_2 = \epsilon = 0$ , education-free model is obtained as follows:

$$\frac{dS_u}{dt} = \varphi - (\lambda_u + \mu) S_u$$

$$\frac{dI_u}{dt} = \lambda_u S_u - (\sigma_u + \mu) I_u$$

$$\frac{dA_u}{dt} = \sigma_u I_u - (\mu + \delta_u) A_u$$

## 8.3. Existence of steady states of the system

The equilibrium points of the system can be obtained by equating the rate of changes to zero.

$$\frac{dS}{dt} + \frac{dI}{dt} + \frac{dA}{dt} = 0$$

## 8.4. Numerical experiment

We showed analytically that the developed model equation is locally asymptotically stable at the disease free equilibrium point. In this sub-section, we carry out the effect of public health education campaign on the compartmentalized population

## INITIA DATA

**Table 1: Initial Values for the Numerical Experiments**

<b>Variables</b>	<b>Description</b>	<b>Value</b>	<b>SOURCE</b>
N	Adult population	19	Kenya bureau of statistics census 2009
$S_u$	Uneducated susceptible individuals	14	Kenya bureau of statistics census 2009
$S_e$	Educated susceptible individuals	0.1421	Kenya bureau of statistics census 2009
$I_u$	Uneducated infected with no AIDS symptoms	2	Kenya bureau of statistics census 2009
$I_e$	Educated infected with no AIDS symptoms	0.087	Kenya bureau of statistics census 2009
$A_u$	Uneducated infected with AIDS symptoms	0.2	Kenya bureau of statistics census 2009
$A_e$	Educated infected with AIDS symptoms	0.0009	Kenya bureau of statistics census 2009

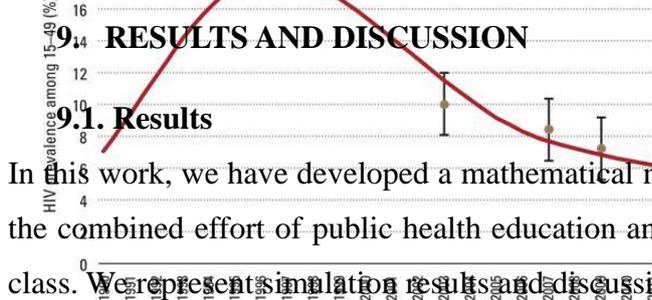
<b>Parameters</b>	<b>Description</b>	<b>Nominal value</b>	<b>SOURCE</b>
$\lambda_u$	Force of infection of uneducated individuals	0.2541	Gumel et al.
$\lambda_e$	Force of infection of educated individuals	0.0164	Gumel et al.

$\Pi$	Recruitment rate of susceptible	3.2000	Kenya bureau of statistics census 2009
$\mu$	Natural mortality rate	0.0154	Kenya bureau of statistics census 2009
$\delta_u$	Disease-induced mortality rates for uneducated individuals	0.4700	Gumel et al.
$\delta_e$	Disease-induced mortality rates for educated individuals	0.0400	Gumel et al.
$\rho$	Fraction of educated newly-recruited individuals	0.5000	Elbasha and Gumel
$\xi$	Rate of educating susceptible	0.5000	Elbasha and Gumel
$\psi_1$	Education rates of individuals in $I_u$ class	0.5000	MATLAB's Statistical Toolbox
$\psi_2$	Education rates of individuals in $A_u$ class	0.5000	MATLAB's Statistical Toolbox
$\beta$	Effective contact rate	0.4000	Elbasha and Gumel
$\eta_u$	Modification parameters for uneducated individuals	1.5000	MATLAB's Statistical Toolbox
$\eta_e$	Modification parameters for educated individuals	1.2000	MATLAB's Statistical Toolbox
$\varepsilon$	Efficacy of educated in preventing infection	0.5000	MATLAB's Statistical Toolbox
$1-\kappa$	Reduction in	0.3000	MATLAB's

	transmissibility of educated individuals		Statistical Toolbox
$\sigma_u$	Progression rates to AIDS for uneducated class	2.6000	Karen and Susan
$\sigma_e$	Progression rates to AIDS for educated class	0.0700	Karen and Susan

Estimated HIV prevalence in urban settings in Kenya

The initial conditions used are as follows:  $S_u(0) = 14$  million,  $S_e(0) = 0.4121$  million,  $I_u(0) = 2$  million,  $A_u(0) = 0.2$  million,  $I_e(0) = 0.087$  million, and  $A_e(0) = 0.0009$  million.



In this work, we have developed a mathematical model for the dynamics of HIV/AIDS under the combined effort of public health education and drug therapy at the exposed and infected class. We represent simulation results and discussion on results as follows;

**9.1.1. Simulation of results**

We give a graphical representation of our experimental results with varying rates of  $\beta$  is the effective contact rate,  $\lambda$  the forces of infection and  $\mu$  is the Mortality rate.

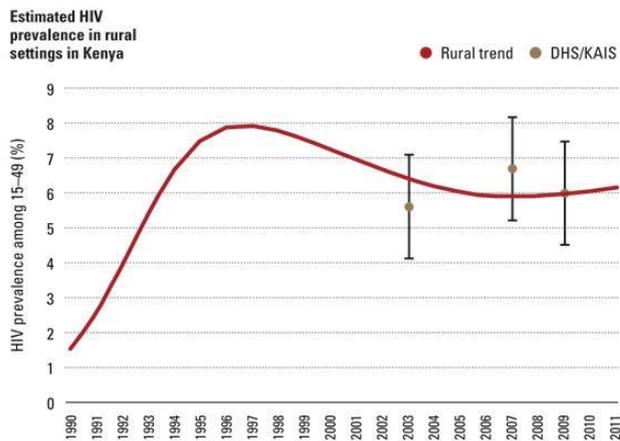
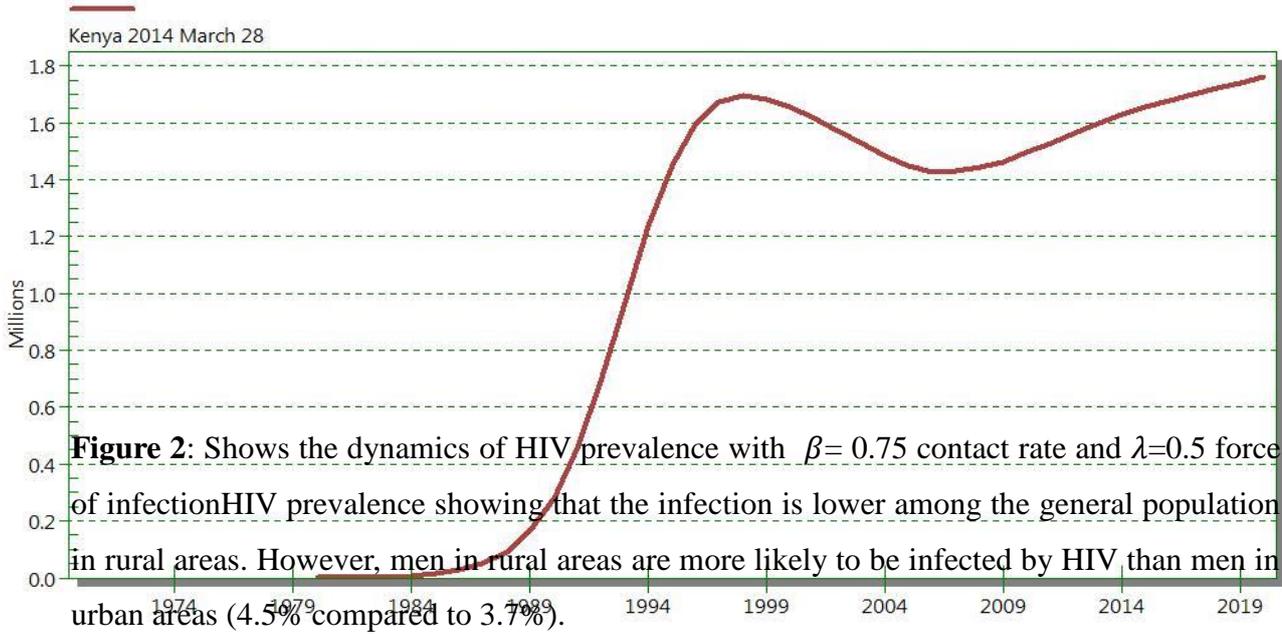
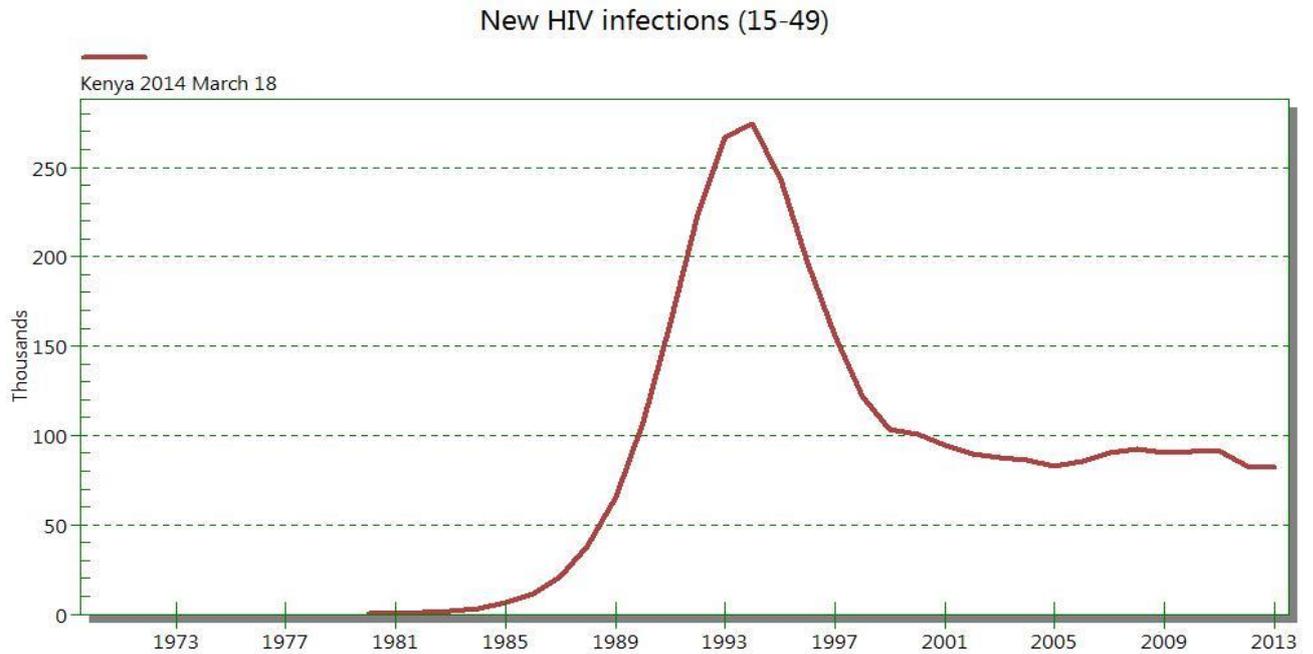


Figure 1: Shows the dynamics of HIV prevalence with  $\beta = 0.45$  contact rate and  $\lambda=0.25$  force of infection that shows the prevalence being higher among the general population in urban areas.

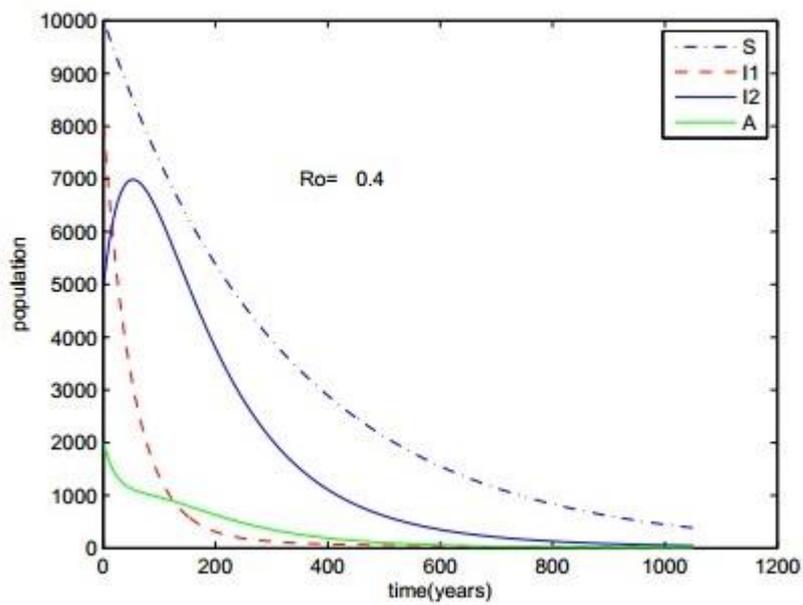
## HIV population



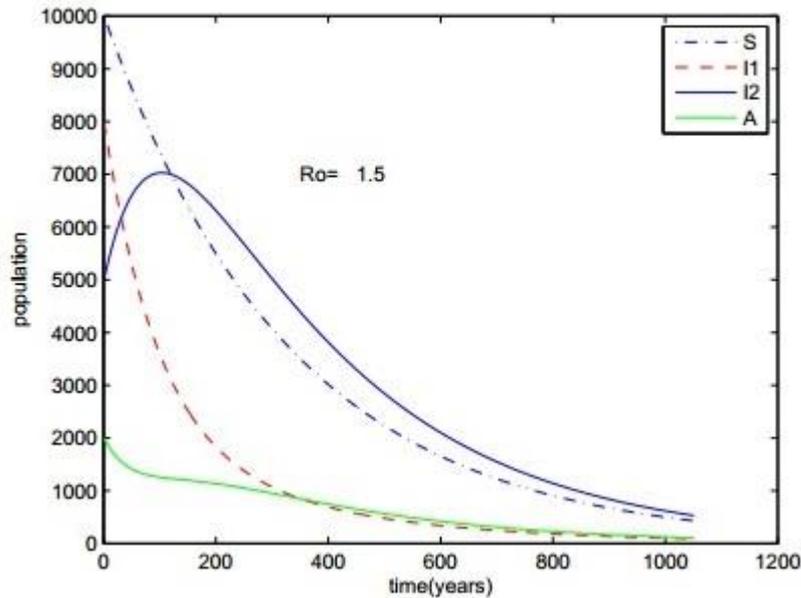
**Figure 3 :** Shows the dynamics of HIV prevalence with  $\beta=0.95$  contact rate ,  $\lambda=0.75$  force of infection and  $\mu = 0.45$ , This shows that the number of people living with HIV is estimated to have increased from about 1.4 million in 2009 to 1.6 million in 2013. Women constitute about 57% of the infected population, while men account for 43%. About 80% to 90% of the infected populations are adults. Though the HIV prevalence rate has been on the decline in the last few years, the number of people living with HIV and AIDS has been on the increase, and is currently estimated at 1.6 million. This number is projected to increase due to improved survival (reduced mortality due to HIV) attributed to ART program.



**Figure 4:** Shows the dynamics of HIV prevalence with  $\beta = 0.45$  contact rate,  $\lambda=0.25$  force of infection and  $\mu = 0.3$ . This shows that the trend in new infections among adults aged 15-49 for the period up to 2013. New infections among adults contribute over 80% of the total new infections. The new infections among adults stabilized at an average of 93,000 annually over the last five years. Among children, new infections declined from about 20,000 to 11,000 annually over the same period. An estimate of new infections among men and women and children is shown in the table below



**Figure 5. :** Graph showing the dynamics of HIV/AIDS with  $R_0 = 0.4$ , these results shows the effect of public health education e.g Safe sex, condom use, counseling and testing and abstinence as an intervention approach on HIV/AIDS disease.



**Figure 6. :** Graph showing the dynamics of HIV/AIDS with  $R_0 = 1.5$ , shows when HIV/AIDS exist in the population where public health education is limited to only one strategy e.g, abstinence alone or counseling and testing as the only strategy, hence these simulations suggest a single strategy is not enough in the fight against the epidemic.

### 9.1.2. DISCUSSION

We established the disease-free Equilibrium point (DFE) and analyzed the stability of our model at disease free equilibrium point. The analytical results showed that our model is locally asymptotically stable when the basic reproduction number,  $R_0 < 1$ . The basic reproduction number,  $R_0$ , can solve concrete problems since it completely determines the stability dynamics and outcome of the disease. It was found that if the threshold parameter is less than one the disease free equilibrium is stable and the disease dies out. However, if the threshold parameter is more than one, there exists a unique endemic equilibrium that is locally asymptotically stable. Theoretical determination of threshold conditions for  $R_0$ , is of important public health interest. We reach total agreement with WHO and UNICEF recommendations on HIV/AIDS control, as herd resistance increases with number of opportunity. Some techniques are not suitable to know if the free-disease equilibrium point is globally stable; in such case, the disease can be eradicated irrespective of the initial sizes of the compartment, as encountered in the real situation. Any other limitation is the lack of success when prospecting global stability for SEIR epidemiological models with non-constant population. This is directed to the stakeholders, public health agencies health care

providers and the various county governments to enable them determine how best to allocate scarce resources for HIV/AIDS prevention and management in the country. The model has shown success in attempting to predict the causes and reason for rapid spread of HIV/AIDS transmission within a certain population. The model strongly indicated that the spread of a disease largely depend on the contact rates with infected individuals within a population.

The model also pointed out that early detection and therapeutic treatment has a positive impact on the reduction of HIV/AIDS transmission; that is there is a need to detect new cases as early as possible so as to provide early management and treatment for the disease. More people should be educated in order create awareness to the disease so that the community will be aware of the deadly disease. Eradication of contagious diseases such as HIV/AIDS has remained one of the biggest challenge facing developing countries.

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## Mathematical Modeling of Delayed Pulse Vaccination Model of Infectious Diseases

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### ABSTRACT

This study concerns the theoretical determination of a mathematical model of delayed pulse vaccination of infectious diseases that affects children. In this study, a delayed SEIR epidemic model with impulsive effect and the global dynamic behaviors of the model will be analyzed. Using the discrete dynamical systems determined, it's shown that there exists an 'infection-free' periodic solution which is globally attractive when the period of impulsive effect is less than some critical value. The sufficient condition for the permanence of the epidemic model with pulse vaccination is given, which means the epidemic disease is to spread around. The study has concluded that time delay and pulse vaccination brings great effects of shortening 'infection period' on the dynamics of the model. The results indicate that a large vaccination rate or a short period of pulsing leads to the eradication of the disease. Numerical simulation has been used together with the analytical results. The results shall be presented in tabular and graphical form.

### KEYWORDS

Basic reproduction ratio- $R_0$       Compartmental model      Infectious diseases      Disease-free Equilibrium      Mathematical modeling      Pulse vaccination      Time delay

### Introduction

Infectious diseases are disorders caused by pathogenic microorganisms. Many organisms live in and on our bodies. Most infectious diseases could be driven towards eradication, if adequate and timely steps (e.g. vaccination, treatment, etc.) are taken in the course of an epidemic. However, many of these diseases eventually become endemic in many societies due to lack of adequate policies and timely interventions to mitigate the spread of the diseases. Consequently, there is the need for proactive steps towards controlling the spread of infectious diseases, particularly those ones for which both vaccine and cure are available.

The ultimate goal of an epidemic model would be to closely follow and predict real-life disease outbreaks, with the aim of informing public policy and related government agencies. It will focus on looking at control methods, i.e. ways to keep the infective population low or to eradicate the infection altogether. One such control method is vaccination. Some vaccination campaigns are run continuously, for example with people of a certain age receiving their vaccine. Another way is to organize large campaigns in which a large proportion of the population is vaccinated over a short time; this technique is known as pulse vaccination.

In modeling of delayed pulse vaccination of infectious diseases, the study focuses on deterministic models and dynamical systems used to model epidemics, using deterministic compartmental models, in which a given population is divided into compartments based on the disease status (susceptible, exposed etc.). The transfers between compartments, as well as the entrance to the population of new individuals and the exit of others are modeled as terms in a differential equation governing the time-evolution of each compartmental value. After the infectious individuals lived through an infection period, they recover completely and transfer to the 'removed' class, R, so, the number of the death of the infectious should be considered during convalescence, which is called the phenomena of 'time delay'.

Pulse vaccination is gaining prominence as a strategy for the elimination of childhood viral infectious diseases such as measles, hepatitis, parotitis, smallpox and phthisis, and was considered in many literatures in D'Onofrio (2002, 2004) and Gao (2008). Known theoretical results showed that the pulse vaccination strategy can be distinguished from the conventional strategies in leading to disease eradication at relatively low value of vaccination.

Therefore, this study will consider an epidemic model with impulsive vaccination and time delay and study their dynamic behaviors (the 'infection-free' periodic solution, the permanence and the global attractive behavior) under pulse vaccination. The main aim of this study is to introduce time delay, pulse vaccination in an epidemic model and to obtain some important qualitative properties and valid pulse vaccination strategy.

### **Related works/Literature survey**

Wencai *et al* (2015) researched on dynamical analysis of SIR epidemic model with non-linear pulse vaccination and lifelong immunity. In this study, due to the limited medical resources, vaccine immunization rate is considered as a nonlinear saturation function and their findings were enriching medical resources the disease will be in extinction, otherwise the disease will

be permanent.

Onyejekwe and Kebede (2015), studied the epidemiological modeling of measles infection with optimal control of vaccination and supportive treatment, in which they concluded that the optimal combination of the strategies required to achieve the set objective depend on the relative cost of each of the control measures and the resulting optimality system. The use of both vaccination and supportive treatment gives the highest possible rate to the control of epidemics.

Tongqian *et al* (2014), in their study SVEIRS a new epidemic disease model with time delays and impulsive effects realized that global dynamical behavior of the model with pulse vaccination and impulsive population inputs effects at two different periodic moments, existence and global attractivity of the infection free periodic solution and also permanence of the model. Their results shows that time delay, pulse vaccination and pulse population input can exert a significant influence on the dynamics of the systems which confirms the availability of pulse vaccination strategy for the practical epidemic prevention.

Shulgin *et al* (2014) considered a simple SIR model with pulse vaccination and have shown that if certain conditions regarding the magnitude of vaccination proportion and on the period of pulses are satisfied then the pulse vaccination leads to epidemic eradication.

Yanke and Rui (2010), investigated a delayed SIR epidemic model with nonlinear incidence rate and pulse vaccination, they noted that the global attractiveness of infection free periodic solution was analyzed and sufficient conditions are obtained for permanence of the system. Their results indicated that a large vaccination rate or a short period of pulsing leads to the eradication of the disease.

An epidemic HIV/AIDS model with treatment has been investigated in the study by Cai *et al* (2009). The model allows some infected individuals to move from symptomatic phase to the asymptomatic phase by all kinds of treatments. The authors introduced the time delay to the model in order to investigate the effect of the time delay on the stability of the endemically infected equilibrium. This discrete time delay has also been used to the model to describe the time from the start of the treatment in the symptomatic stage until the treatment effects becomes clear. It was found that treatment can be used to make the disease free equilibrium ( $E_0$ ) stable when it would be unstable in the absence of treatment. On the other hand using the time delay can induce oscillation in the system. Biologically, this means that there is a critical value for the treatment-induced delay which determines the stability of the infected equilibrium  $E^*$ . That is, the infected equilibrium  $E^*$  is asymptotically stable when antiretroviral drugs on average show positive effects in patients within less than time delay.

D'Onofrio *et al* (2007) presented simple epidemiological models with information dependent vaccination functions which can generate sustained oscillations via Hopf bifurcation of the endemic state. The onset of these oscillations depends on the shape of the vaccination function. They used “global” approach to characterize the instability condition and identify classes of functions that always lead to stability/instability. The analysis allows the identification of an analytically determined “threshold vaccination function” having a simple interpretation: coverage functions lying always above the threshold always lead to oscillations, whereas coverage functions always below never lead to instability.

Meng *et al* (2008) and Jin *et al* (2008) studied an SIR model with some people failing to obtain immunity after first dose but gained immunity after later doses. As it's known immunity to infectious diseases after being vaccinated against them might not be life long, so in this study it's assumed that the latent and immunity (not permanent) period are constants.

The control of epidemics by vaccination, by Verriest *et al* (2011), they used recently developed results on optimal impulsive control for time delay systems in the problem of control of an epidemic through pulse vaccination. For added realism, delays are explicitly incorporated in the epidemiological model. It was shown that the conditions for optimality are easily amenable by an iterative gradient type numerical algorithm. They recommended future work to include multipulse strategies. They expected that current policies of *periodic* vaccination pulses can be improved upon. This will then provide a 'proof of principle' with which more realistic models for disease may be attacked.

The combination of pulse vaccination in an epidemic model with time delay is the main objective of this study, focusing on pulse vaccination. The study of the pulse vaccination model with delay as given by Gao (2009) will be the basis of this research.

### **Purpose of the study**

Infectious diseases have been a major concern in health sector, as it affects children and young borns adversely. Constant vaccination have been used mostly as a method of controlling infectious diseases e.g. measles, polio, etc. Pulse vaccination is the latest advancement in health sectors hence its study.

### **Objectives of the study**

The main objective of this study is to model the infectious diseases, come up with the control measures to enable their eradication and determine the effect of the various population parameters on the delayed pulse vaccination using delayed differential equations, also to:

- i. To determine and analyze contact rate parameters which are piecewise constant or time-varying of epidemiological modeling for the disease eradication or become incurable.
- ii. To determine the effects of delay and non-delay pulse vaccination models in the control of an epidemic outbreak.
- iii. To obtain the model for simulating delayed pulse vaccination of infectious diseases.
- iv. To obtain the threshold values for which an outbreak will die or persist in the population.
- v. To discuss the implications of the model for the management of the infectious diseases.

### **Methods/Discussion**

In this study we analyse the deterministic compartmental model of the infectious disease on the population. A deterministic compartmental model is one in which the individuals in a population are classified into compartments depending on their status with regard to the infection, the compartments are; Susceptible –  $S(t)$ , Exposed/latent but not yet infectious –  $E(t)$ , Infected –  $I(t)$  and the Removed –  $R(t)$  for  $SEIR$  model. There are many different compartmental epidemic models for example we have  $SEIR$ ,  $SIR$ ,  $SI$  model and others. The differential equations (DE) will be assigned initial conditions (IC) and boundary conditions (BC) which will help to solve them. The time-varying or constant parameters will be determined for the dynamical system. The partial differential equations governing the deterministic models have been used. In mid-19th century, the Xinzhi L and Peter S (2009) discussed different theorems of aiding in solving partial differential equations.

- i) The existence and uniqueness theorem,
- ii) The stability theorems, and
- iii) The Comparison theorems.

After presenting theorems applicable to very general systems of differential equations, then apply them to the following systems based on the equations of D'Onofrio *et al* (2005).

#### **a) Non-delay SIR Model**

$$\left. \begin{aligned} \frac{dS}{dt} &= b(N(t) - S(t)) - \beta \frac{I(t)}{N(t)} S(t) \\ \frac{dI}{dt} &= \beta \frac{I(t)}{N(t)} S(t) - (\mu + \gamma) I(t) \\ \frac{dR}{dt} &= \gamma I(t) - \mu R(t) \end{aligned} \right\} \dots\dots\dots 2.1$$

**b) Delay SEIR Model:**

$$\left. \begin{aligned} \frac{dS}{dt} &= b(N(t) - S(t)) - \beta \frac{I(t)}{N(t)} S(t) \\ \frac{dE}{dt} &= \beta \frac{I(t)}{N(t)} S(t) - \beta e^{-\mu r} \frac{I(t-r)}{N(t-r)} S(t-r) - \mu E(t) \\ \frac{dI}{dt} &= \beta e^{-\mu r} \frac{I(t-r)}{N(t-r)} S(t-r) - (\mu + \gamma) I(t) \\ \frac{dR}{dt} &= \gamma I(t) - \mu R(t) \end{aligned} \right\} \dots\dots\dots 2.2$$

**c) The DELAY SEIR model with Pulse vaccination**

$$\left. \begin{aligned} dS/dt &= bN(t) - \mu S(t) - \beta \frac{I(t)}{N(t)} S(t) \\ dE/dt &= \beta \frac{I(t)}{N(t)} S(t) - \beta e^{-\mu r} \frac{I(t-r)}{N(t-r)} S(t-r) - \mu E(t) \\ dI/dt &= \beta e^{-\mu r} \frac{I(t-r)}{N(t-r)} S(t-r) - (\mu + \gamma) I \\ dR/dt &= \gamma I - \mu R \end{aligned} \right\} t \neq \kappa\tau \dots\dots\dots 3.1$$

$$\left. \begin{aligned} S(t) &= (1-p)S(t^-) \\ E(t) &= E(t^-) \\ I(t) &= I(t^-) \\ R(t) &= R(t^-) + pS(t^-) \end{aligned} \right\} t = \kappa\tau$$

**2.2.1 Ordinary Differential Equations**

An ordinary differential equation (ODE) is an equation that involves some ordinary derivative of a function which can be solved by integration.

$$x'(t) = f(t, x) \dots\dots\dots 2.3$$

Here theorems for a general ordinary differential equation (ODE) are discussed, which will be relevant to later analysis. This equation is non-autonomous since it depends explicitly on the time variable  $t$  in addition to the state variable  $x(t)$ . It's assumed that the ODE is subject to the initial condition (IC)

$$x(t_0) = x_0.$$

$$\dots\dots\dots 2.4$$

These theorems are:

**i. The Existence and uniqueness theorem**

**a) Local existence theorem**

Peano's existence theorem gives conditions for when a solution to equation 2.3 exists:

**Theorem 1: Peano's Existence Theorem:** Let  $f \in C(F, R^n)$ , that is,  $f$  is a continuous function from  $F$  to  $R^n$  where

$$F = \{(t, x) \in R \times R^n : |t - t_0| \leq a, \|x - x_0\| \leq c, a, c > 0\} \dots\dots\dots 2.5$$

and let,  $\|f(t, x)\| \leq M$  on  $F$  for some  $M > 0$ . Then the IVP (2.3-2.4) has at least one solution  $x(t)$  defined on  $[t_0 - \alpha, t_0 + \alpha]$  where  $\alpha = \min(a, \frac{c}{M})$ .

**b) Equal Birth and Death Rates**

If  $\mu = b$  and the population is normalized to  $N(t) = S(t) + I(t) + R(t) \equiv 1$ , equation (2.1) becomes:

$$\left. \begin{aligned} dS/dt &= \mu(1 - S(t)) - \beta I(t)S(t) \\ dI/dt &= \beta I(t)S(t) - (\mu + \gamma)I(t) \\ dR/dt &= \gamma I(t) - \mu R(t) \end{aligned} \right\} \dots\dots\dots 2.6$$

Defining  $x = [S, I, R]^T$  and  $f(t, x) := [x^1, x^2, x^3]^T$ . Then (2.1) is equivalent to  $x'(t) = f(t, x)$ .

In this normalized case, the physical region is  $x \in \Omega_1 := \{(S, I, R) \in [0, 1]^3 : S + I + R = 1\}$  since  $S, I$ , and  $R$ , are fractions of the population. This region is positively invariant.

Since  $S(t), I(t), R(t) \geq 0$  and  $S(t) + I(t) + R(t) = 1$ . Thus  $\|f(t, x)\| \leq M_1$  for all  $x \in \Omega_1$ . If we choose any compact region  $F = \{(t, x) \in R^+ \times \Omega_1 : |t - t_0| \leq a, \|x - x_0\| \leq c\}$ , then we have  $f \in C(F, \Omega_1)$  and  $\|f(t, x)\| \leq M_1$  on  $F$ . Therefore by Peano's Existence Theorem, Equation (2.3) has at least one solution on  $[t_0 - \alpha, t_0 + \alpha]$ , where  $\alpha = \min(a, \frac{c}{M})$ . Notice that if we choose  $c \geq 3$  then  $\{x : \|x - x_0\| \leq c\} \supseteq \Omega_1$

**c) Allowance for Population Growth**

If the birth and death rates are unequal,  $b \neq \mu$ , then the boundedness of the model is slightly

more difficult to prove, since the population sizes may grow. The physical region of interest is now (potentially) unbounded; thus we define  $\Omega_N = R_+^3$  (where  $R^+ = [0, \infty)$ ). The region  $\Omega_N$  is positively invariant with respect to the DE 2.3:

$$S(t) = 0 \Rightarrow S' = \mu > 0 \quad I(t) = 0 \Rightarrow I' = 0: \quad R(t) = 0 \Rightarrow R' = \gamma I(t) \geq 0$$

so with these initial conditions in  $\Omega_N$ , the trajectory of the solution will never leave  $\Omega_N$ . This analysis assumes the total population will undergo exponential growth or decay depending on the relative values of  $b$  and  $\mu$ .

### SEIR MODEL WITHOUT VACCINATION

The differential equations for this model are;

$$\frac{dS}{dt} = bN(t) - \beta S(t) \frac{I}{N} - \mu S(t) \quad (1)$$

$$\frac{dE}{dt} = \beta S(t) \frac{I}{N} - (\sigma + \mu) E(t) \quad (2)$$

$$\frac{dI}{dt} = \sigma E(t) - (\gamma + \mu + \delta) I(t) \quad (3)$$

$$\frac{dR}{dt} = \gamma I(t) - \mu R(t) \quad (4)$$

$\frac{dN}{dt} = 0$ , and  $N = S + E + I + R$  is thus constant.

#### Properties of the SEIR Model Equations

The basic properties of the of the model equations 1-4 are feasible solutions and positivity of solutions.

#### Feasible solution

The feasible solution set which is positively invariant set of the model is given by,

$$\emptyset = \left\{ (S, E, I, R) \in R: S + E + I + R = N \leq \frac{b}{\mu} \right\} \quad R_+^4$$

#### Positivity of solutions

A first-order linear differential equation of the form,

$$\frac{dN}{dt} = (b - \mu)N. \text{ Thus } N(t) = Ce^{(b-\mu)t} \text{ at } t=0 \quad N(0) = C$$

Hence the solution of the linear differential equation then becomes

$$N(t) = N(0)e^{(b-\mu)t} \text{ Therefore, } \emptyset \text{ is positively invariant.}$$

#### Existence of steady states of the system

The equilibrium points of the system can be obtained by equating the rate of changes to zero.

$$\frac{dS}{dt} + \frac{dE}{dt} + \frac{dI}{dt} + \frac{dR}{dt} = 0$$

#### Global asymptotic stability of the model

In proving the global stability of the SEIR Model, there is need to find the equilibrium points

of the system 5-8.

Assuming that the birth rate,  $b$  is equal to death rate,  $\mu$  i.e.  $b=\mu$ .

### 1. The Analysis of the SEIR Model without pulse vaccination

This section gives an illustration of the analytical results of the SEIR model without pulse vaccination by carrying out stability analysis and numerical simulations of the model using the parameter values pertinent to Kenya given in Table 4.1 below. These parameters were obtained from different sources in the literature

**Table 4.1: Parameter symbol, values and their sources**

Parameter symbol	Parameter value	Literature source
$b$	0.02755 per year	Gao et al(2009)
$\mu$	0.00875 per year	Gao et al(2009)
$\beta$	0.09091 per day	D'onofrio (2004)
$\sigma$	0.125 per day	Gao et al(2009)
$\alpha$	0.14286 per day	Momoh et al(2013)

### 4.1 Stability analysis of the Model

From model 3.1 when no time delay then the equations becomes

$$\begin{aligned}\frac{dS}{dt} &= b(N(t) - S(t)) - \beta \frac{I(t)}{N(t)} S(t) \\ \frac{dI}{dt} &= \beta \frac{I(t)}{N(t)} S(t) - (\mu + \gamma) I(t) \\ \frac{dR}{dt} &= \gamma I(t) - \mu R(t)\end{aligned}$$

#### Endemic Model

$$\frac{ds}{dt} = \mu - (\mu + \beta i) s$$

$$\frac{de}{dt} = \beta s i - (\mu + \sigma) e$$

$$\frac{di}{dt} = \sigma e - (\mu + \gamma + \delta) i$$

$$\frac{dr}{dt} = (\gamma + \delta) i - \mu r$$

Linearising the system of the differential equations, the Jacobian matrix is given as

$$J(s,e,i,r) = \begin{bmatrix} \mu + \beta i & \mu & 0 & \mu \beta \\ \beta i & \mu + \sigma & \mu & b \\ 0 & b & \mu + \gamma + \delta & 0 \\ 0 & 0 & 0 & \gamma + \delta \end{bmatrix}$$

For the infection free equilibrium  $(s,e,i) = (1,0,0)$ , the Jacobian matrix then becomes

$$J(1,0,0) = \begin{bmatrix} -\mu & 0 & -\beta \\ 0 & -(\mu - \delta) & \beta \\ 0 & \delta & -(\mu - \sigma) \end{bmatrix} = \begin{bmatrix} -0.0875 & 0 & -0.09091 \\ 0 & -0.2125 & 0.09091 \\ 0 & 0.125 & -0.230336 \end{bmatrix}$$

The important sub-matrix is the second 2x2 matrix. From this, the trace  $(T) < 0$ , but if  $R_0 < 1$ , then the determinant  $(D) > 0$  and if  $R_0 > 1$  then  $(D) < 0$  for all parameters

Routh-Hurwitz stability condition for T and D is given as follows:

$$T = -(\mu + \sigma + \alpha) = -0.44286 \text{ and } D = (\mu + \alpha)(\mu + \sigma)(1 - R_0) = 0.02488$$

Hence the disease free study state when  $R_0 < 0$ , and unstable when  $R_0 > 0$ . The eigenvalues at the disease free equilibrium are given by  $\{-\mu, -(\mu + \sigma), -(\mu + \alpha)\}$ . All the eigenvalues are negative meaning the disease free equilibrium  $(1, 0, 0, 0)$  is asymptotically stable. The

$$\text{endemic equilibrium } (s^*, e^*, i^*) = \left( \frac{1}{R_0}, \frac{\mu(R_0 - 1)}{R_0(\mu - \sigma)}, \frac{\mu(R_0 - 1)}{\beta} \right)$$

The Jacobian matrix for the endemic equilibrium is given as

$$J_{\text{endemic}} = \begin{pmatrix} -\mu R_0 & 0 & -(\mu + \alpha)(\mu + \sigma) \\ \mu(R_0 - 1) & -(\mu + \sigma) & (\mu + \alpha)(\mu + \sigma) \\ 0 & \sigma & -(\mu + \alpha) \end{pmatrix}$$

Whose Characteristic equation is given as  $X^3 + a_1X^2 + a_2X + a_3 = 0$

Routh-Hurwitz criteria for stability, all the roots of the Characteristic equation have negative real part which means stable equilibrium is attained.

## 4.2: Optimal Vaccination Strategies

### 4.2.1: Herd immunity

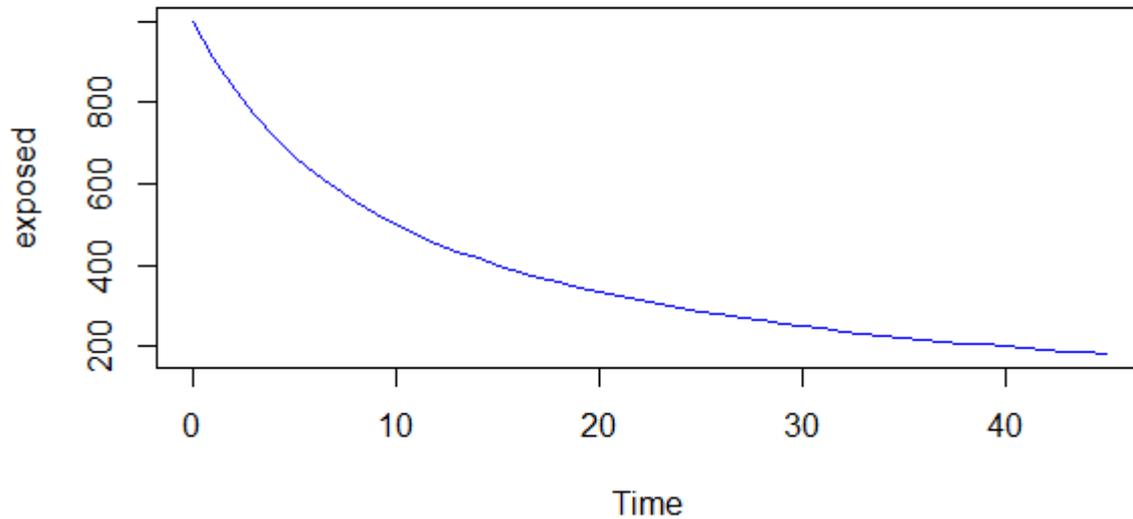
Herd immunity is the level of immunity in a population which prevents epidemics, even if some transmission may still occur. It is well-known that the higher  $R_0$  is for a disease, the higher the proportion of the population will have to be vaccinated to achieve herd immunity as seen by Hethcote (1989). Although, this statement could seem theoretical, it was almost the perspective followed by *WHO's Technical Working Group*(2000), when devising strategies to control a full range of diseases; for instance, this procedure has succeeded during the worldwide campaign for measles and smallpox eradication in the 1960s.

### 4.2.2: The condition for control.

Let  $p$  be the proportion immune after a vaccination campaign. To reach the so-called critical proportion  $p_c$ , we need the control condition  $R_0(1 - p_c) < 1$  to be fulfilled. For instance, in most sub-Saharan Africa countries, the basic reproductive number for measles  $R_0$  is

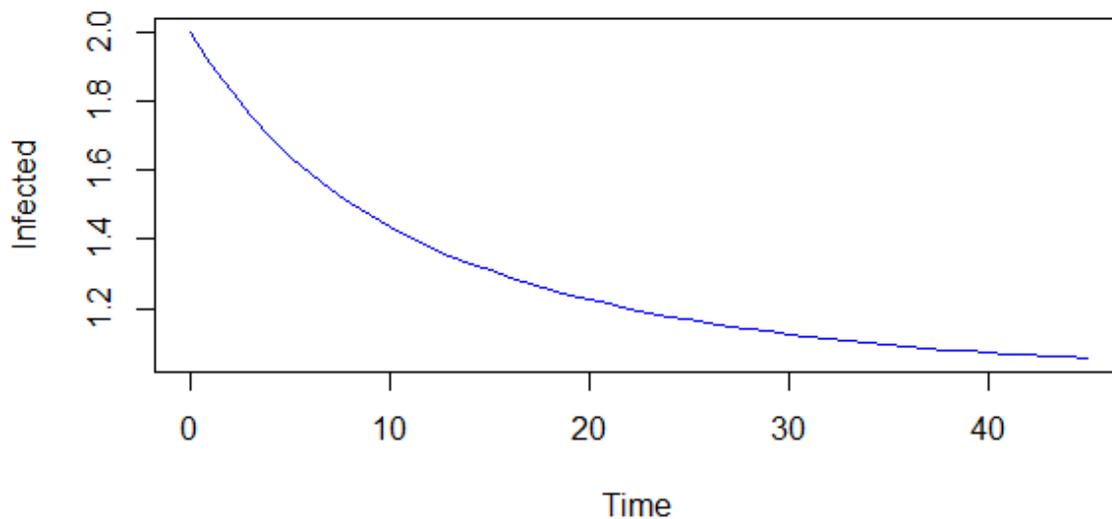
approximately around 18 by Hethcote (1989) and Grais (2006), so  $p_c = 0.94$ . Under the schedule of a unique dose, the minimal coverage to control infectious diseases is such that everyone does not need to be immune through vaccination to control infectious diseases.

#### 4.3 Numerical simulations and Analysis of the Simulations of the SEIR model equations.



**Figure 1:** Simulation of the Exposed Population

In **Figure 1** it can be observed that as the rate increases, the population of exposed individuals shows some rapid decrease after the earlier intervals of rise. The decrease in the exposed population could be due to early detection and also possibly due to those who enter the infective class. This decrease could also be due to the education about the infectious diseases transmission, very few individuals are coming out as infected individuals. Also the dynamics of the exposed population depend on the contact number.



**Figure 2:** Simulation of the Infected Population

In **Figure 2**, it is realized that the population of infected individuals at the very beginning rise sharply as the rate increases and then fall uniformly as time increases. This rapid decline of the infected individuals may be due to early detection of the measles and partly due to those who revert to the Exposed class. This graph also demonstrates that the contact rate has large impact on the spread of the disease through population. If the contact rate is observed to be high then the rate of infection of the disease will also be high as would be expected logically. However, there exists another parameter to consider as more individuals are infected with the disease and  $I(t)$  grows, as some individuals are leaving the infected class by being cured and joining the recovered class.

## 4.5 Conditions for control of infectious diseases

### 4.5.1 Herd immunity

Herd immunity is defined as the level of immunity in a population which can prevents epidemics

of a disease, even if some transmission of that particular disease may still occur in a population.

If the percentage or proportion of the population that is immune exceeds the herd immunity level for the disease, then the disease can no longer persist in that particular population. Thus, if this level of immunity can be exceeded by means of mass vaccination, then the disease can indeed be eliminated.

Assuming that, the herd immunity level is denoted by  $v$ . Recall that, for a stable state:  $R_0 \times S = 1$  so that,  $S$  will be  $(1-v)$ , since  $v$  is the proportion of the population that are immune and  $v + S$  must be equal to one (since in the simplified model everyone one susceptible or immune ). Then:

$$R_0 \times (1-v) = 1, 1-v = \frac{1}{R_0}, v = 1 - \frac{1}{R_0} \quad \text{and therefore, } v = (1 - 0.0625) \times 100 = 93.75\%$$

Now let me assume that, in a given population if the average age at which a disease is contracted is  $A$  and the average life expectancy in that same population is given as  $L$ .

And it is assumed that everyone in the population lives to age  $L$  and then dies. If the average age of infection is  $A$ , then on average, individuals younger than  $A$  are susceptible and those older than  $A$  are immune. Thus the proportion of the population that is susceptible is given by  $S = \frac{A}{L}$ .

But mathematical definition of the endemic steady state can be arranged to give;

$$S = \frac{1}{R_0}, \text{ therefore, } \frac{1}{R_0} = \frac{A}{L} \text{ and this implies that } R_0 = \frac{L}{A}.$$

By using the available data,  $R_0$  can be estimated.

#### 4.5.2 WHEN MASS VACCINATION CANNOT EXCEED THE HERD IMMUNITY

If the mass vaccination due to the outbreak of a disease is insufficiently effective or the required coverage cannot be reached due to some reasons, for example in some community where the people have agree not to permit their children to be vaccinated due to some personal reasons, the programme may not be able to exceed  $q_c$ .

Suppose that a proportion of the population  $v$  (where  $v < q_c$ ) is immunised at birth against an infection with  $R_0 > 1$ . The vaccination programme changes  $R_0$  to  $R_q$  where  $R_q = R_0 (1 - v)$ , this change is as a result of now fewer susceptible will be in the population who can be infected.  $R_q$  is simply  $R_0$  minus those that would normally be infected but that cannot be now since they are immune. As a consequence of this lower basic reproduction number, the average age of infection  $A$  will also change to some new value  $A_q$  in those who have been left unvaccinated. Assuming that life expectancy has not changed, now

$$R_q = \frac{L}{A_q}, A_q = \frac{L}{R_q}, A_q = \frac{L}{R_0(1-v)}$$

$$\text{But } R = \frac{L}{A} \text{ So } A_q = \frac{L}{\frac{L}{A}(1-v)}, A_q = \frac{AL}{L(1-v)}, A_q = \frac{A}{1-v}, A_q = \frac{A}{S}$$

The vaccination programme caused the lowering of basic reproductive number, and this will

also produce an increase in the average age of infection. Unvaccinated individuals now experience a reduced force of infection due to the presence of the vaccinated group.

#### **4.5.3 When mass vaccination exceeds the herd immunity**

If a vaccination programme causes the proportion of immune individuals in a population to exceed the critical threshold for a significant length of time, transmission of the infectious disease in that population will gradually come to a halt.

#### **4.6 Discussion**

The main objective of this study is to model delayed pulse vaccination of infectious diseases and also establish a possible way of reducing the disease transmission.

The basic reproductive number has been computed to determine the stability of the disease because theoretical determination of threshold conditions for  $R_0$  is of important public health interest. It was established qualitatively that the model has the disease-free equilibrium and endemic equilibrium points. It was realized that whenever  $R_0 < 1$ , the disease-free equilibrium point is locally asymptotically stable and unstable whenever  $R_0 > 1$ .

It was also realized that, in the absence of mass vaccination programme as well as early detection and supervised treatment, the transmission of the disease cannot be eradicated from the population. The introduction of proper treatment and education about the disease transmission as well as early detection of the disease can help reduce the disease in a population. The results has also shown that effective contact with the infectious individual cause a major increase of the disease transmission, hence individuals with active infectious disease must be detected as early as possible to reduce high rate of transmission in a population. Education about infectious disease can help many appear for diagnosis and get detected early.

#### **1. The SIS Model**

This model is for diseases which the infection does not confer immunity. It is called an SIS Model since individuals return to the susceptible class when they recover from the infection. Naturally occurring births and deaths (vital dynamics) are included, but the behavior of solutions is similar when vital dynamics are not included.

#### **2. The SIR Model without vital dynamics**

In this model, the diseases considered for which the infection confers permanent immunity. When such an SIR disease goes through a population in a relatively short time (less than one year) then this disease outbreak is called an epidemic. Since an epidemic occurs relatively quickly, the model does not include births and deaths (vital dynamics). Epidemics are

common for diseases such as influenza, measles, rubella and chickenpox.

### 3. The SIR Model with vital dynamics

In this section an SIR epidemiological Model is considered, but here a model of the disease behavior in the population over a long time period. A disease is called endemic if it is present in a population for more than 10 or 20 years. Because of the long period involved, a model for an endemic disease must include births as a source of new susceptible and natural deaths in each class.

By Theorem 2 and above discussions, we know that the set  $\Omega_0$  is a global attractor in  $\Omega$ , and of course, every solution of system (3.11) with initial conditions (3.12) will eventually enter and remain in region  $\Omega_0$ . Therefore, system (3.11) is permanent. The proof of Theorem 3 is complete.

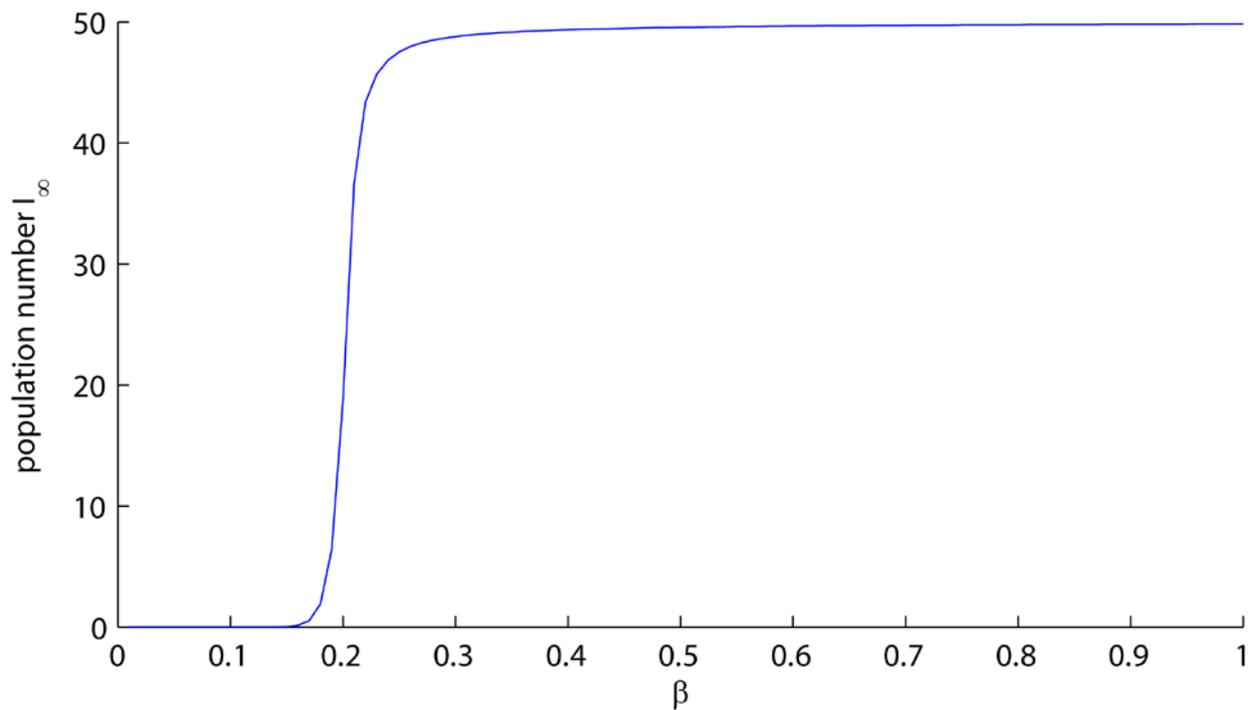
$$S^* = \frac{(\sigma + \alpha + \mu)(\gamma + \mu + \delta)}{\alpha\beta}, \quad V^* = \frac{(\sigma + \alpha + \mu)(\gamma + \mu + \delta)}{\alpha\beta(\varphi + \mu)}, \quad I^* = \frac{\alpha\beta B(\varphi + \mu) + \varphi\lambda(\sigma + \alpha + \mu)(\gamma + \mu + \delta)}{\beta(\varphi + \mu)(\sigma + \alpha + \mu)(\gamma + \mu + \delta)} - \left(\frac{\lambda + \mu}{\beta}\right)$$

$$E^* = \frac{\alpha\beta B(\varphi + \mu) + \varphi\lambda(\sigma + \alpha + \mu)(\gamma + \mu + \delta)}{\beta(\varphi + \mu)(\sigma + \alpha + \mu)} - \left(\frac{\lambda + \mu(\gamma + \mu + \delta)}{\alpha\beta}\right)$$

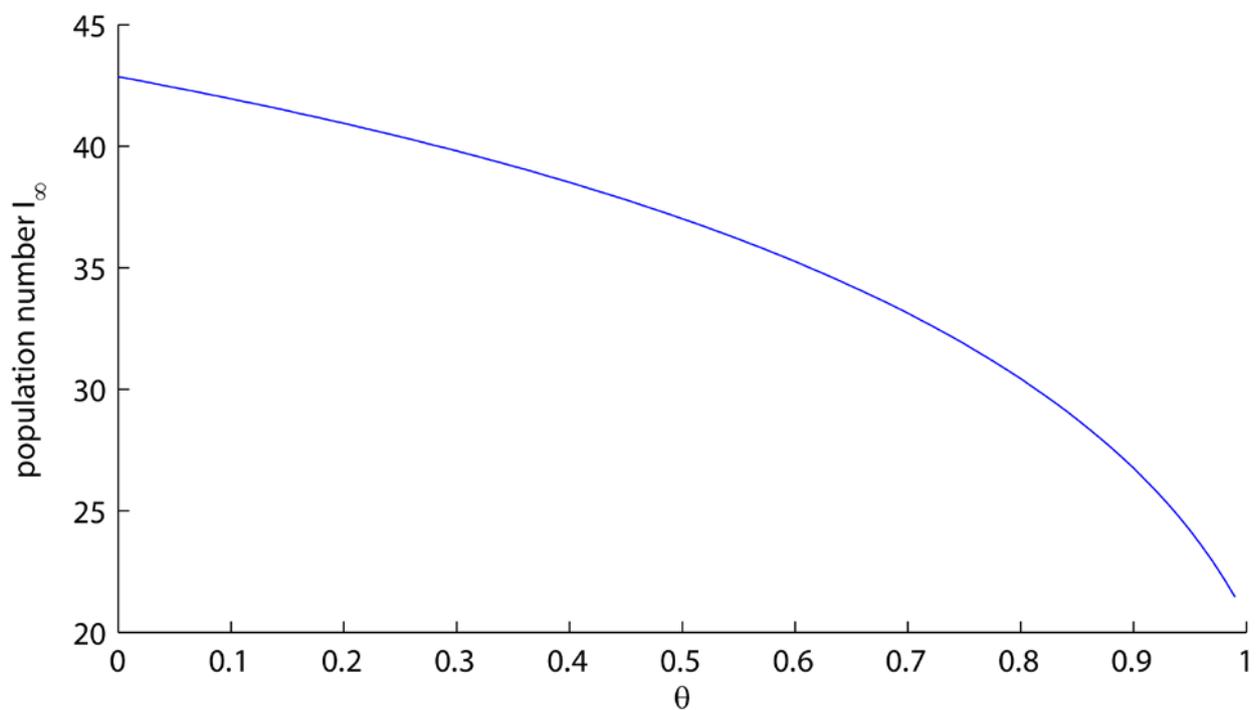
$$E^* = \frac{\sigma\alpha\beta}{\mu(\sigma + \alpha + \mu)(\gamma + \mu + \delta)} + \frac{\lambda\sigma\varphi(\gamma + \mu + \delta)}{\mu\beta(\varphi + \mu)} - (\lambda + \mu)\frac{(\gamma + \mu + \delta)}{\alpha\beta\mu} + \frac{\alpha\gamma\beta}{\mu(\sigma + \alpha + \mu)}$$

$$\begin{aligned} dE/dt &= \beta S(t)I(t) - (\sigma + \alpha + \mu)E(t) \\ dI/dt &= \beta S(t)I(t) - (\mu + \gamma + \alpha)I \end{aligned}$$

We have analyzed the SIR epidemic model with pulse vaccination and distributed time delay. Two thresholds have been established, one for global stability of the infectious-free solution and one for persistence of the endemic solution.



**Figure 3** The bifurcation diagram the unique endemic equilibrium (the component  $I$  of infectious individuals regarding  $\beta$  as the bifurcation parameter, all other parameters are same as in model (5.1)).



**Figure 4.** The bifurcation diagram the unique endemic equilibrium (the component  $I$  of infectious individuals regarding  $\theta$  as the bifurcation parameter, all other parameters are same

as in model (5.1) except for  $\beta = 0.214$  ).

From Figures 1 and 2, we can observe the following:

- (i)  $R^*$  and  $R_*$  are inversely proportional to  $\theta$  value and directly proportional to  $\tau$  value and  $R_0$  value, which implies that pulse vaccination measures the inhibition effect from the behavioral change of the susceptible when they transfer to the infectious class ( $I$ ).
- (ii)  $R^*$  is a directly proportional to  $\mu$  value, which implies that the natural birth or death rate measures the inhibition effect from the behavioral change of the susceptible class (with  $S$ ) when it moves into the infectious class ( $I$ ).
- (iii)  $R_*$  is inversely proportional to  $h$  value, which implies that the maximum infectious period of the disease measures the inhibition effect from the behavioral change of the susceptible class (with  $S$ ) when it moves into the infectious class  $I(t)$ .
- (iv) There is a value  $\mu^*$  such that  $R_*$  is directly proportional to  $\mu$  when  $\mu < \mu^*$  and is inversely proportional to  $\mu$  when  $\mu > \mu^*$ . Therefore the larger death rate is sufficient for the global attractivity of infection free periodic solution  $(\tilde{S}(t), 0)$ . It is easy to verify. In fact, we can calculate the derivative of  $R_*$  with respect to  $\mu$

$$\frac{dR^*}{d\mu} = \frac{(1-\theta)e^{-\mu h} R_0}{[1-(1-\theta)e^{-\mu h}]^2} g(\mu), \dots\dots\dots 3.52$$

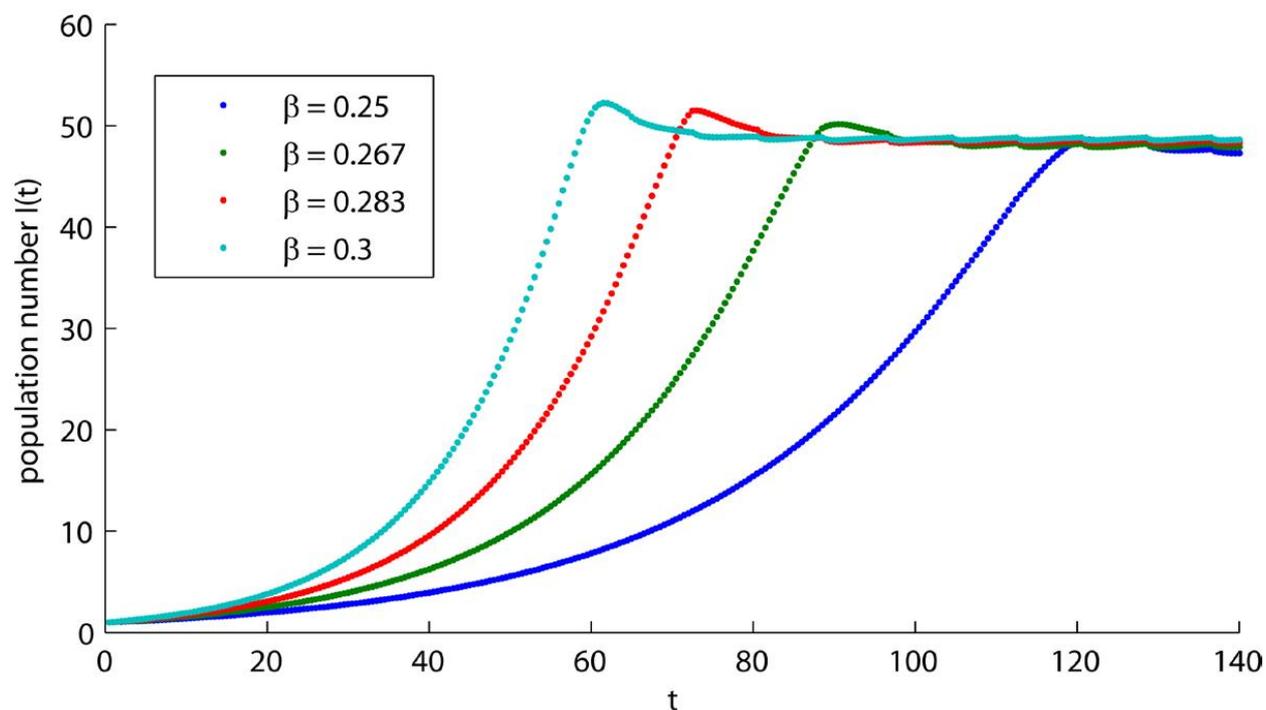
Where  $g(\mu) = \theta\tau e^{-\mu\tau} - h(1 - e^{-\mu\tau})(1 - (1 - \theta)e^{-\mu\tau})$ . Obviously,  $g'(\mu) < 0$  and  $g(0) > 0$ ,  $\lim_{\mu \rightarrow +\infty} g(\mu) < 0$ . Hence, there exists a  $\mu^*$  such that  $dR^*/d\mu > 0$  for  $\mu \in (0, \mu^*)$ , whereas  $dR^*/d\mu < 0$  for  $\mu \in (\mu^*, +\infty)$ .

Epidemic models with time delays have received much attention since delays can often cause some complicated dynamical behaviors. Delays in many models can destabilize equilibrium and thus lead to periodic solutions by Hopf bifurcation Hethcote *et al* (1981), Cooke L. and Busenberg S. (1993). It is well known that periodic forcing can drive SIR and SEIR models into a behavior which looks chaotic, Smith L. and Schwartz B.(1983).

The impulsive model with distributed time delay (3.11) will be analyzed, in particular paying attention to the following points:

- (i) The global asymptotic stability for SIR model with pulse vaccination and distributed time delay;
- (ii) The behavior of the model when an insufficient level of people undergoes the vaccination: bifurcation and chaotic solutions;
- (iii) Whether periodic or pulse vaccination does a better job than constant vaccination at the same average value.

**Figure 5:** Time series of system (2.1) \*  $\theta = 0.214, R = 1.0529$



**Figure 5** The tendency of the infected individuals  $I$  with different values of  $\beta$

Therefore, an interesting open problem is proposed whether we can prove that the positive periodic solution of model (2.1) is globally attractive as  $R > 1$ .

Finally, the numerical simulations of the stroboscopic map of model on the number of infected individuals with different values of  $\beta$  are shown in **Figure 5**. It shows that the number of infected individuals will increase steadily in next few days, then reach the peak and begin a slow decline, and finally become stable. The greater the value  $\beta$ , the bigger the peak value and the earlier the peak appears. Our result implies that decreasing infection rate

can put off the disease outbreak and reduce the number of infected individuals.

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