IMPROVING QUALITY OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORTS: A STATISTICAL ANALYSIS

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ABSTRACT
Environmental and Social Impact Statement (ESIS) for a proposed development is vital in guiding decision makers arrive at an informed decision. Many studies have analysed ESIS quality using qualitative methods with limited statistical analysis. In this paper, we present findings of a statistical analysis of qualitative data of ESIS using Somers' delta test (Somers'*d*). We report on how public participation and analysis of alternatives influence the quality of ESIS. Results show that there is a strong and positive correlation between the quality of ESIS and public participation and also between the quality of ESIS and the analysis of alternatives, which is statistically significant, $p < 0.0005$, Somers' $d = 0.676$ and $p < 0.0005$, Somers' $d = 0.682$, respectively.
Keywords: alternatives analysis, environmental and social impact statements, public participation, Somers' delta test.

1 INTRODUCTION

Environmental and Social Impact Assessment (ESIA) is vital for the integration and evaluation of environmental and social concerns of a proposed development [1–2]. The outcome of ESIA process is documented in an Environmental and Social Impact Statement (ESIS). An effective ESIA process translates to a good-quality ESIS, which is vital in informing decision [3–4]. Indicators of an effective ESIA include the extent to which environmental awareness is raised and environmental values are incorporated into decision-making [5]. Likewise, attributes such as early implementation [6–8], comprehensive public consultation [8–9], multiple alternatives analysis [3, 10] and information disclosure [11] are vital for an effective ESIA. Differing stakeholder locus on the need for a thorough and collaborative process to ensure overall good quality [12] gives rise to the concern that ESIA process is often unnecessarily lengthy and an economic burden to proponents [13]. The quality of ESIS is a major dimension of an effective ESIA system [3]. ESIS for a proposed development action is vital in guiding decision makers to arrive at an informed decision. Whereas the overall quality of the ESIS is important, the significance of each section of the ESIA (review area) and subsections (subcategory) is not the same when informing decisions on a proposed development action [14]. Identification and evaluation of key impacts and the environmental management plan and follow-up are considered more important sections than the description of a proposed development, baseline conditions and presentation of environmental impact statement [14]. These two ESIA sections are considered more important in informing decision-making because they not only incorporate the study of the environment but also impact predictions based on scientific data combined with the expertise and experience of the consulting team preparing the ESIS [10]. It is vital that the identification of probable impacts should be aided

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by the scoping process [15], manuals and computer programs [16]. Impact prediction should be based on reliable predictive models [17–18], checklists and matrices [2]. Matrices such as Leopold Matrix (LM) and Lohani and Thanh impact evaluation and analysis methods [19] combined with baseline data, and professional judgement can be vital in predicting cumulative impacts for proposed development actions [2]. Evaluation of the predicted impacts perhaps is the most difficult aspect of impact assessment [15] as it is a complex and subjective process. In some instances, algorithms that combine predictions and the subjective values of affected parties have been used [15]. Therefore the ESIS should not only state the methods used for impact identification but also the justification of its use. Use of appropriate methodologies will ensure comprehensive evaluation of significance of impacts on the affected community and biophysical environment.

1.1 Stakeholder participation during impact assessment

Public participation in Environmental Impact Assessment (EIA) process is defined as 'the involvement of individuals and groups that are positively, or negatively affected by, or that are interested in, a proposed project, program, plan or policy, that is subject to a decision-making process' [7]. Stakeholder participation in EIA process is crucial as it provides adequate opportunities to stakeholders to raise their concerns, increase awareness and capture local and traditional knowledge, enhances transparency, builds trust, informs decision-making and legitimizes public decisions [20–22]. Involvement of the community during ESIA process is an important step in ESIA process. Community involvement and participation are part of the compulsory stakeholder and public participation process [15] when undertaking ESIA. The participation of all categories of stakeholders during impact assessment process should be rigorous and sustained throughout and in all stages of the process including decision-making stage [9]. Civil society groups that include an array of non-governmental organizations (NGOs), for example, play a vital role in promoting public participation in environmental governance [23]. NGOs contribute to improved public participation during impact assessment through advocacy, capacity building, mobilization and information sharing with other stakeholders, especially local communities and project-affected persons [23]. Public participation during scoping ensures the inclusion of potential impacts that are of greater concern to all stakeholders [24]. Stakeholder consultation and participation add value to developments and minimizes potential delays brought about by misunderstandings and opposition from stakeholders such as local communities or civil society groups [8]. Well planned and executed comprehensive and transparent public participation during impact assessment contributes to a more comprehensive and balanced Impact Statement that informs decisions [9]. Elaborate stakeholder involvement during Impact Assessment process can contribute to the improvement of the quality of the impact statement [25]. Stakeholder issues and concerns, including potential conflicts from a proposed development action, are more likely to be identified during public participation process [26]. Difficulties and challenges phased when promoting public participation during impact assessment process include the way it is designed and implemented [7] as it is not initiated early nor sustained throughout the ESIA process [9].

1.2 Alternatives consideration and analysis during impact assessment

Alternatives are defined as 'options, choices, or courses of action; they are means to accomplish ends, these ends include not just a particular agency's goals, but also broader societal

goals such as the protection and promotion of environmental quality' [18]. Although consideration of alternatives is important in EIA process [17], scientific research on this topic is limited [27]. Although alternatives consideration is a core element of EIA [3, 27–28], its development and consideration are poor and weak [18, 29] with a low environmental relevance of the alternative assessed [27]. Timely identification and evaluation of alternatives in policies, plans and programmes can evade potential hitches at the project level [30]. Determination and analysis of alternatives is important if impact assessment process has to remain relevant, creative and problem solving [3]. Since alternatives provide a framework for successive decision-making by a competent authority [17], their thorough consideration should begin early in project planning phase before decisions are made on scale, type of development and project location [10]. Lack of adequate scientific data combined with inadequate expertise experience are some of the difficulties and challenges phased when considering and analysing alternatives [10].

1.3 ESIA for geothermal energy projects in Kenya

Requirement of EIA for proposed development projects was legislated in Kenya in 1999 [31]. Over time, refinement of the EIA legislations and practice has resulted in the mainstreaming of social considerations in the assessment, effectively transforming EIA to ESIA highlighting the link between environmental and social impacts [32]. Legislations of national standards on air quality [33], noise and vibration [34], water quality [35] and waste management [36] have not only served to abate environmental pollution but are a vital social safeguard and constitutional right to a clean and health environment [37–38]. Thus, over the years ESIA practice in the country has progressed as the procedures, standards and practice have been refined [39]. These legislations combined with the legislation on conservation of biological diversity and resources [40] underpin the need for comprehensive consideration of all impacts through in-depth understanding of all the biophysical and social changes arising from proposed project [39, 2]. Geothermal energy development in Kenya is categorized as high risk [41] hence ESIA is mainstreamed in its development [2, 39, 26, 42] before implementation for informed decision [43]. Prior to constitutional and legislative underpinning of ESIA in Kenya, geothermal energy development had already been subjected to ESIA as part of the financiers' requirement [39, 44–45], specifically the World Bank Environmental Assessment (EA) policy and Operational Directive (OD) 4.00 [46]. The first geothermal energy development project in Kenya to be subjected to a comprehensive ESIA was Olkaria II in 1994 [39, 44–45]; thereafter, all other subsequent geothermal energy projects have been subjected to detailed ESIA [39, 43–45, 47]. ESIA for geothermal development in the country has a history; hence, the quality of resulting ESIS for geothermal energy projects has evolved over time [39].

1.4 Statement of the problem

Although there are many ESIA studies carried out for proposed projects in developing countries, including Kenya, research on the quality of the Impact Statements is limited [3]. Moreover, the few documented studies on the quality of Impact Statements in developing countries have focused on qualitative methods with limited statistical analysis. Yet, statistical analysis is important when determining factors influencing the quality of impact statements [3]. This paper contributes to addressing this research gap.

1.5 Study objective

To find out how public participation and analysis of alternatives affect the quality of environmental and social impact statements.

1.6 Research question

Does stakeholder participation and analysis of alternatives affect the quality of an ESIA statement?

2 METHODOLOGY

2.1 Study sample

The study sample (n) consisted of 15 ESIA reports for geothermal energy projects in Kenya. This sample size was the entire study population (N). Since N was small that is less than 100 items, the entire study population became the sample size (n) to ensure it reflected variations in the study population [48] while allowing the use of intensive methods of data extraction, such as content analysis that generate enormous amount of qualitative data [49].

2.2 Study variables

The study covered three variables, one dependent and two independent. The quality of Environmental and Social Impact Statements (ESIS) was the dependent variable (response variable), while public participation and alternative analysis were the independent variables (predictors). The dependent variable was ordinal, ordered and ranked on a 6-point Likert scale based on the Lee and Colley Review Package (LCRP) [50], while the independent variables were ordinal categorized into five groups. Subcategories of each variable informed the ranking, variable subcategories were ranked in ascending order according to the extent a subcategory reflected the magnitude of variation in the variable [51]. The study focused on the two predictor variables (public participation and alternative analysis) because stakeholder participation during Impact Assessment process is critical in contributing to the improvement of quality of the impact statement [25] and, hence, the need for its in-depth analysis. Likewise, alternatives consideration was critical as it is a core element of EIA [3, 27–28]. Each variable addressed a specific question that contributed to answering the research question as shown in table 1.

2.2.1 Dependent variable data collection procedure

To collect data on the quality of ESIS, content analysis of fifteen ESIS for geothermal energy projects in Kenya was carried out [49]. Data on the quality of each ESIS was extracted based on the LCRP [50]. The LCRP criterion, which is based on international best practice, consists of multiple criteria hierarchically structured in review areas, categories and subcategories [50]. The lowest level is subcategories, second in hierarchy from the bottom review categories, followed by review areas and overall report grade at the top of the hierarchy. In this study, we covered four review areas, 13 categories and 40 subcategories as shown in table 2.

Table 1: Study variables.

Variable	**Research question**	**Variable category**
Public participation	Which stakeholders were consulted during the ESIA process as documented in the environmental and social impact assessment report for the project?	• No participation • Only the general public participated • General public and lead agencies participated • General public, lead agencies & civil society participated • General public, lead agencies, civil society and other interested parties participated
Alternatives analysis	Which alternatives were considered, described and evaluated in the ESIA report for the project?	• Only zero alternative considered and evaluated • Zero and site alternative considered and evaluated • Zero and design alternative considered and evaluated • Site alternatives and design alternates considered and evaluated • Zero alternative, site alternatives and design alternates considered and evaluated
Quality of Environmental and Social Impact Statement	What is the quality of each of the ESIA report reviewed based on Lee and Colley Review Package?	Unsatisfactory Very poor Poor Acceptable Good Excellent

Prior to reviewing, the section of the LCRP on advice to reviewers was thoroughly read and understood. This section is twofold namely advice on how to conduct a review of an EIS and secondly explanatory notes on the interpretation of individual review topics within the review package. The review was conducted by two independent reviewers who were experienced Impact Assessment Practitioners. Significant review differences were first determined and then resolved by each reviewer discussing individual review results and then justifying the assessment grade for the sub-category, category, review area and overall grade, where necessary the final grade was arrived based on consensus. Content analysis of the impact statements was systematically carried out. Starting from the lowest level and moving systematically up the hierarchy, the review involved evaluating how well a number of assessment tasks were performed. The quality of each review subcategory within a particular category

Table 2: Review areas, categories and subcategories.

Area	Category	Subcategory
• Description of the development & baseline conditions	• Project description	• Background and objectives of project • ESIA aims and scope • Policy and legal framework for ESIA
	• Site description	• Location of the project • Project components & activities • Selection of project alternatives
	• ESIA approach & methodology	• Screening • Scoping and bounding
	• Environmental baseline	• Natural physical environment • Biological environment • Socio-economic environment • Sources of data with justification
• Identification & evaluation of key impacts	• Identification of impacts	• Description of impacts identified at different places • Beneficial impacts and adverse impacts • Methods used for impact identification with justification
	• Impact evaluation	• Prediction of impacts • Significance of impacts on affected community • Significance of impacts on biophysical environment • Methods used for evaluation of impacts • Risk and uncertainties
	• Alternatives	• Analysis of alternative • Selection of alternatives
	• Community involvement	• Description of community • Involvement of community at different stages • Approaches of community involvement • Findings of community involvement

Table 2: (*Continued*)

Area	Category	Subcategory
• Environmental management plan and follow-up	• Mitigation measures	• Description of adverse impacts to be mitigated • Mitigation measures with justification • Implementation arrangements of mitigation measures • Residual impacts
	• Follow-up monitoring program	• Parameters/ activities to be monitored • Monitoring plan & implementation arrangements • Reporting & communication of monitoring results
• Presentation of Environmental Impact Statement	• Layout	• Logical arrangement of information • List of references
	• Presentation	• Comprehensible to non-specialists • Defining technical terms • Presented as an integrated whole
	• Executive summary	• Summary of main findings presented non-technically • Recommendations

Source: [50]

Table 3: Quality review assessment grades for the Impact Statements.

Grade	Definition	Explanation
A	Excellent	Relevant tasks well performed, no important tasks left incomplete
B	Good	Generally satisfactory and complete, only minor omissions and inadequacies
C	Acceptable	Considered just satisfactory despite omissions and or inadequacies
D	Poor	Parts attempted but as a whole considered just unsatisfactory because of omissions and inadequacies
E	Very poor	Not satisfactory, significant omissions and inadequacies
F	Unsatisfactory	Very unsatisfactory, important tasks poorly done or not attempted

Source: [50]

was assessed. The subcategory assessment results and the relevant impression gained from the Impact Statement were then used to assess the review category. The result of the assessment of the review category was used to assess each review area of the Impact Statement. The overall quality of the Impact Statement was derived from the outcome of the assessment of each of the review areas by considering the main strengths and weaknesses. Based on the quality of information presented in each of the four areas, assessment grades were assigned to each Impact Statement as defined in table 3.

2.2.2 Independent variables data collection procedure

Data on public participation and alternatives considered and analysed as documented in sampled Impact Statements were extracted. Extraction of data on stakeholder participation from the Impact Statements involved first recording whether there was stakeholder participation or not followed by type of stakeholder participation and combination of stakeholders who participated. Extraction of data on alternatives analysed in the Impact Statements involved extracting information on alternative(s) considered, analysed and the combination of analysed alternatives.

2.3 Data analysis

Somers' delta test (Somers' *d*) was used to analyse the strength and direction of association between the ordinal dependent variable (outcome variable) and ordinal independent variable (predictor variable). Somers' *d*, therefore, measured the association between the predictor variable *x* and an outcome variable *y*. The population value of Somers' *d* [52] is defined as:

$$d_{yx} = \frac{t_{xy}}{t_{xx}} \tag{1}$$

where d_{yx} is a measure of the effect of *x*, on *y*, given predictor variable *x*, and outcome variable *y*, t_{xy} is the difference between two probabilities, namely the probability that the larger of the two values of the predictor variable *x* is associated with the larger of the two values

of the outcome variable y and the probability that the larger value of the predictor variable x is associated with the smaller value of the outcome variable y. Somers' d is asymmetric measure (asymmetric means a distinction is made between a dependent and independent variable) of association between two ordinal variables [53]. Somers' d value range from −1 to +1. A value of −1 indicates that all pairs of observations are discordant and a value of +1 indicates that all pairs of observations are concordant. A value of 0 indicates no association between all pairs of observation [52, 54]. The absolute value of Somers' d indicates the strength of the relationship, while the sign (positive or negative) indicates the direction of the relationship. Somers' d tending towards −1 or 1 suggests the model has good predictive ability, while values tending towards 0 in either direction indicate the model is a poor predictor. To ensure the validity of results obtained, data collection and analysis procedure had to conform to Somers' delta test assumptions. Cross tabulation was used to examine statistical relationship between the ordinal independent variable and ordinal dependent variables. Cross tabulations between two ordinal variables show patterns of association and the direction of the relationship between the variables. All statistical analyses were performed using IBM SPSS Statistics Version 22.

2.4 Conformity of study to Somers' delta test assumptions

2.4.1 Assumption 1: Dependent and independent variable

Two variables of study are to be tested at a time, one has to be dependent and the other independent and both are to be measured on an ordinal scale. This assumption was observed since two of the variables were independent while one was dependent. Likewise, only one of the two independent variables of study were tested at a time against the dependent variable.

2.4.2 Assumption 2: Monotonic relationship between dependent and independent variable

A monotonic relationship exists when either: (a) the variables increase in value together or (b) as one variable value increases, the other variable value decreases. This assumption was observed from the ordering of the independent variables into five categories and the number of attributes in each category of the independent variables, likewise from the ordering and ranking of the dependent variable on a 6-point Likert scale.

3 RESULTS

3.1 Public participation vis-à-vis quality of ESIS

Somers' d was run to determine the association between the quality of ESIS and public participation in a sample of 15 ESIS for geothermal energy projects in Kenya. There was a strong, positive correlation between the quality of ESIS and public participation, which was statistically significant ($d = 0.676$, $p < 0.0005$) as shown in Table 4.

3.2 Alternatives analysis vis-à-vis quality of ESIS

Somers' d was run to determine the association between the quality of ESIS and analysis of alternatives in a sample of 15 ESIS for geothermal energy projects in Kenya. There was a strong, positive correlation between the quality of ESIS and analysis of alternatives, which was statistically significant ($d = 0.682$, $p < 0.0005$) as shown in Table 5.

Table 4: Directional measures: public participation vis-à-vis quality of ESIS.

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by ordinal	Somers' *d*	Symmetric	0.694	0.091	5.761	0.000
		Public participation comprehensiveness Dependent	0.714	0.085	5.761	0.000
		Quality of ESIS Dependent	0.676	0.125	5.761	0.000

a. Not assuming the null hypothesis
b. Using the asymptotic standard error assuming the null hypothesis

Table 5: Directional measures: alternatives analysis vis-à-vis quality of ESIS.

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by ordinal	Somers' *d*	Symmetric	0.690	0.125	4.516	0.000
		Alternatives considered and analysed Dependent	0.699	0.123	4.516	0.000
		ESIS quality Dependent	0.682	0.129	4.516	0.000

a. Not assuming the null hypothesis
b. Using the asymptotic standard error assuming the null hypothesis

4 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

4.1 Quality of ESIS and public participation association

The model had a good predictive ability in predicting the association between the independent variable and the dependent variable as the Sumers' *d* value tended towards +1 and was statically significant, p = 0.000. Public participation therefore strongly influenced the quality of ESIS as indicated by the strong positive association between the dependent and independent variables. Somers' *d* value of 0.676 implies that comprehensive public participation contributes to improving the quality of ESIS by 67.6%. Comprehensiveness of public participation is a function of the number of categories of stakeholders consulted and actively participating in the ESIA process. Therefore, the participation of diverse number of stakeholders is likely to contribute to improving the quality of ESIS. The contribution of public participation in improving the quality of the ESIS was very poor when only one category of stakeholder participated. However, contribution to improving the quality of the Impact Statement improved with the increase in the number of stakeholder groups and categories participation in the ESIA process. Public participation has been documented in other studies to contribute

to the improvement of the quality of impact statements [9, 24, 55]. Public participation has been shown to be statistically significant in underpinning conflict identification during impact assessment [26] and improving the quality of impact statements [3]. Each stakeholder category has a unique role to play during impact assessment as they bring on board unique yet diverse knowledge, experiences and interests.

4.2 Quality of ESIS and alternatives analysis association

Alternative analysis strongly influenced the quality of ESIS as indicated by the strong positive association between the dependent and independent variables. Somers' *d* value of 0.682 implies that alternatives considered and analysed improves ESIS quality by 68.2%. Holding other factors constant, the more the number of alternatives considered and analysed, the better the quality of the Impact Statement. Holding other factors constant, an analysis of project site and design alternatives resulted in a better-quality Impact Statement compared to when zero and design alternatives or zero and site alternatives were analysed.

4.3 Conclusion

We used the statistical method 'Somers delta test' to analyse the quality grade data of Environmental and Social Impact Statements by analysing a sample of 15 Impact Statements for geothermal energy projects in Kenya. While holding other factors constant, the study established that there is a strong and positive correlation between the quality of the Impact Statements, public participation and analysis of alternatives. To ensure these factors are adequately supported during ESIA process, adequate resources should be allocated to ensure that all factors that are vital in improving the quality of Impact Statements (including public participation and analysis of alternatives) are adequately covered and comprehensively addressed. Whilst there are various factors that influence the quality of an Impact Statement, this study has statistically shown that stakeholder participation and alternatives analysis are among the factors that have a direct significant effect on Impact Statement quality. In addressing all factors that affect the quality of Impact Statements, adequate time and financial and human resources should be availed to facilitate comprehensive and transparent participation of as many categories of stakeholders as possible during the impact assessment process. Equally, all possible alternatives to a proposed project should be identified, carefully considered and thoroughly and exhaustively analysed. All alternatives considered and analysed should be scientifically underpinned, logically reasoned, socially acceptable and stakeholder supported. Adequate considerations to required qualifications, training and relevant experience of the team of Impact Assessment Practitioners selected to execute a given impact assessment assignment will be important.

4.4 Recommendation on future research

This paper analysed the effect of stakeholder participation and alternatives analysis on the quality of Impact Statements separately. There are other factors such as impacts identification, impacts description, impacts prediction, impact evaluation, impact mitigation and monitoring among others that affect the quality of Impact Statements. Future research could focus on the combined statistical analysis of these factors to determine their effect on the quality of Impact Statement when collectively analysed.

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