Development of a Web Based Electronic Procurement System

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Abstract: A well-functioning procurement system is an essential requirement for a developing country like Kenya. In order to promote development, proper management of scarce resources is vital. A system that ensures transparency, efficiency, cost effectiveness, easy to control and monitor can accelerate development to great heights. It will encourage fair competition and freedom of information amongst trading partners in a regional block. This can be achieved by using an electronic government procurement system realized as a web based internet portal. This paper explores the design methodology applicable to the design and implementation of an electronic Government Procurement System (e-GP). The paper further shows how Object Oriented technology can be applied to model the business artifacts of the system through the Unified Modeling Language (UML). The internet provides a lot of information through the web that makes better decisions to be made quickly.

Keywords: E-Procurement, UML, Web Application Portal

INTRODUCTION

Government procurement (GP) is the buying and selling of goods and services on behalf of a public entity or authority. Government procurement accounts for a substantial part of the global economy. In developing countries such as Kenya, it accounts for up to 20% of Gross Domestic Product (GDP) [1]. Because of this considerable size of procurement market, GP is an important aspect of international trade and therefore subject to international treaty under the auspices of the World Trade Organization (WTO). The process involves research to identify project or service and its preparation, requesting for proposals and for information, bid delivery and evaluation to awarding of contracts. Since public resources are scarce, the efficiency of the procurement process is a primary consideration of every procuring entity. Most countries therefore have laws that regulate GP more or less closely to prevent waste, corruption, fraud and local protectionism policies through tariffs and quotas. Government procurement in the European Union is regulated and harmonized by European Union Laws since the 1970s. European regulations also provide for electronic means in conducting a public procurement procedure for the purchase of goods, works or services. Russian Federal Law of 21.07.2005 require all federal, regional and municipal government customers to publish all information about government tenders, auctions and other purchase procedures on special public government websites. US government procurement is generally governed by the Federal Acquisition Regulation (FAR) which appears in the Code of Federal Regulations. In Kenya procurement is done according to the rules set out by the Kenya Public procurement and Disposal Act 2005.

LITERATURE REVIEW

E-Government Procurement (e-GP)

Electronic Government Procurement is the use of electronic Government platform over electronic resources such as the World Wide Web and Web-based applications to buy and sell goods and services on behalf of a public authority. This is a type of electronic commerce that takes place between governments, between government authorities, government and private organizations or government and the members of the public. The amount of trade conducted electronically has grown extraordinarily with widespread use of the internet. This kind of trade has facilitated many innovations in electronic money transfer, supply chain management, website marketing, online transaction processing, electronic data interchange (EDI), inventory management and automated data collection mechanisms. Modern electronic commerce typically uses the internet at least at one point in the transaction's life-cycle, although it may encompass a wider range of technologies such as electronic mail, mobile devices and telephones as well. The benefits of e-procurement are enormous and include improved efficient monitoring and control, cost effective, reliable and convenient. Consequently these are the catalysts driving the growth in e-procurement.

E-GP in Europe accounts for about 16% of GDP [3]. The adoption of e-procurement in Europe lead to tremendous reduction in costs as well as improved operational efficiency in the procurement process which is largely been attributed to well established IT infrastructure, high levels of computerization and a robust internet and broadband penetration even in rural areas. A survey conducted in 2007 shows over 60% of German and British firms use online purchasing [Batenburg, 2007].

E-GP System for the Government of Indian

According to Mr. Ramanathan Somasundaram in a report for UNESCAP [4], several State governments and public sector organizations such as Andhra Pradesh and Gujarat have already adopted e-procurement under a large umbrella program of e-governance. Using e-Procurement these governments have been able to save on procurement of goods and services. There is also a goodwill factor involved and a definite improvement in the governments' image and transparency. Included in these benefits are cost reduction, improved decision making, process efficiency, price and supplier-behavior forecasting, and supplier-performance monitoring which ultimately leads to vendor rationalization and standardization. The state of Andhra Pradesh launched the e-procurement initiative in 2001 at a time when the infrastructure was severely limited and very few computers existed in the government offices. Thus, Andra Pradesh serves as a valuable model for developing regions because it demonstrates that it is possible to establish an e-procurement system in spite of limited financial resources and IT infrastructure. The procurement system implemented in Andhra Pradesh was based on a public private partnership.. The paper-based procurement system was inefficient and severe challenges had to be overcome such as physical obstruction and intimidation of suppliers at the bidding site or corruption and destruction of bids.

E-GP System for the Korean Government

The GePS of the Republic of Korea was selected as the best e-procurement practice model by the United Nations in November 2004. In a UNESCAP[4] report presented by Mr. Hyung-Jong Min, Director General, Public Procurement Service of Republic of Korea (PPS), the system was described to have the following well established modules:

- Electronic data interchange (EDI) with customers and suppliers in 1997
- E-shopping mall for commercially available products in 1998
- E-Tendering in 2000
- E-payment in 2001
- Government e-procurement system in October 2002 for use by all public organizations

The major functions of GePS include:

- Provides an "end-to-end" electronic procurement service where all procurement processes are conducted on-line
- Serves as a "Single Window" for public procurement – integrates and announces all public institutions' bid information and shares all suppliers' information
- Linked with 53 other institutions' systems

GePS provides more sophisticated services such as wireless e-bidding, mobile information services and property management through radio frequency identification (RFID). Electronic customer relationship management (e-CRM) services include optimized services for each customer and consulting services via a web call centre. High value added services such as D/W services, cost analysis, evaluation of bidders and e-catalog based on ontology are also available.

The most notable achievements of GePS include:

- Used by about 30,000 institutions and 150,000 businesses

- Exchanges approximately 100,000 documents online a day
- World's largest cyber market with an annual transaction volume of US$ 43 billion in 2004
- Saves US$ 3.2 billion worth of transaction costs annually
- Improves transparency in doing business with the government
- Leads the development of private sector e-commerce

Overview of Procurement Process in Kenya

Regulatory framework

In Kenya Public Procurement Oversight Authority (PPOA) [5] is the sole body charged with the regulation of public procurement. It has the functions of ensuring that the procurement procedures established under the Kenya Public Procurement and Disposal Act 2005[6] are complied with and to monitor the public procurement system and report on its overall functioning. It also assists in the implementation and operation of the public procurement system.

The Public Procurement Oversight Advisory Board (PPOAB) advises the Authority generally on exercise of its powers and the performance of its functions; to approve the estimates of the revenue and expenditures of the Authority in accordance with Act.

The Public Procurement Complaints Review and Appeal Board (PPCRAB) and PPOAB are only watch dogs of PPOA

All public procurement is undertaken by a procuring entity (PE) as per threshold matrix as set out in the regulations as stipulated in the Kenya Public Procurement and Disposal Act of 2005[6]. For each procurement activity, the procuring entity can use open tendering, restricted tendering, direct procurement, request for proposals, and request for quotations, procedure for low-value procurement or special permitted procurement procedures.

All Government Procurement Entities (ministries, Parastatals, councils etc) follow a predetermined procedure of procuring commodities or services set out in the Kenya Public procurement and Disposal Act 2005[6]. The regulatory framework sets forth specific guidelines regarding competition requirements at various shilling thresholds. After a statement of needs is defined and a purchase request is processed, the procurement manager should determine the regulatory threshold that applies, and then determine the type of procurement method to be used. When the total transaction value of a purchase is equal or below Ksh.500, 000 this is considered a "micro purchase" and therefore do not require three quotations as long as the prices seem reasonable and purchases are spread out among various suppliers. The procurement manager may simply issue a purchase order to the vendor. Simplified acquisition procedures are supposed to promote efficiency and reduce administrative burden in the contracting process. For transactions equal or over Ksh.500, 000 a solicitation is used to collect at least 3 quotations from suppliers. Depending on the complexity of the procurement, the solicitation can be verbal or written. Solicitation can take the form of a request for quotation (RFQ) or a Request for Proposal (RFP). After

receiving a reasonable number of offers (at least three), the offer that is most advantageous i.e. provides the best value based on delivery schedule, quality and price – wins the award. The whole procurement cycle involves many documents produces at each stage. All sound evaluations have a standardized set of procedures. These are:

- Establish an evaluation methodology. Conduct an administrative evaluation to ensure that the suppliers meet the minimum requirements
- Conduct a technical evaluation including evaluation of past performance
- Conduct a price and delivery schedule evaluation
- Obtain clarifications from vendors, if required or applicable
- Select the best vendor and value for the award of contract
- Ensure that the evaluation is properly documented for the procurement files and any debriefings

However government procurement Entities barely comply with the procedure as set out in the Kenya Public procurement and Disposal Act 2005[7]. Due to these, the government through PPOA often carries out investigations and publishes their evaluation reports in PPOA website. The website contains procurement review reports for among other cooporations: Egerton University, National Water Conservation and Pipeline Corporation, Tana Water Services Board (TWSB), National Social Security Fund (NSSF), Postal Corporation of Kenya (PCK) and others. Looking at these reports reveals that these corporations do not adhere to the following principles to ensure a successful evaluation [7][8]:

- Avoidance of conflicts of interest (actual or perceived)
- Clear and transparent evaluation methodology
- Fair, objective, and rational assessments and ratings
- Procurement integrity — no bribes, kickbacks, or unfair advantages
- Proper storage and Confidentiality of data
- Written narrative of offers/bids strengths, weaknesses, decisions, and procedures
- long delays in processing of documents

It is for these reasons that a proposition on a web based government electronic procurement systems is made that is reliable, transparent, efficient and cost effective.

For many years, the Kenyan government procurement procedure has been done manually by the process of inviting contractors to bid for projects (i.e. Invitation for Prequalification/Tender) to the selection of successful bidders. In this procurement procedure, purchase orders are not normally processed in a timely order and delivery dates are barely met. Kenya's public procurement system is also reportedly prone to corrupt practices, with as many as 45% of companies expecting to give gifts to public officials in order to secure a government contract. Analysis have shown that most contracts awarded by the government or its officials are awarded through corrupt means. Some of these contracts are awarded to contractors who have agreed to

give the procurement official a certain percentage of the original contract amount. This encourages contractors to use substandard goods, render poor services or sometimes project abandonment [9]. These problems form the basis of the following research questions:

1. Can a system be developed that ensures contracts of government properties is made transparent for easy monitoring and control?
2. Can a system be developed to ensure a fair selection of bidders for government projects that is cost effective, efficient and reliable?
3. Can a system be developed that makes use of modern communication technology that is convenient and accessible by a majority of Kenyans?

E-procurement can be defined as applying electronic systems in procurement processes. It can also provide a fair and transparent environment for auctions and enables auction managers to easily handle auction issues. Managing an auction process through such a system, decreases paperwork and increases efficiency. Communication channels, process of receiving auction proposals, proposal evaluation process, and auction closing and opening processes should be considered in order to switch from traditional auction process to electronic and web-based systems. "One of the electronic systems that can be embedded in an e-procurement system is aportal. Portals, by providing integrated framework and connecting people and processes, have a key role in managing complexity, operational performance improvement and value adding processes. Portal technology allows the buyers and suppliers to log onto a portal site, and immediately access the structured and unstructured information. Suppliers can be given insight to the inventory levels of other partners and tune their product based on this information.
Buyers can check the status of orders and received offers from suppliers and select the qualified suppliers for obtaining required goods and services. In addition, procurement process can be harmonized and simplified, by some additional significant features of portal technology. By using portal technology, a company's procurement strategy can be defined and certain administrative tasks can be automated. Additionally the number of un-provided purchases by pre-negotiated contracts is reduced and the traceability is increased." [Seiran Alani Azar,et al]

METHODOLOGY

Various Software development methodologies, models, techniques and approaches have been used over time to develop both off-the shelf and client-based software. In this paper, the software development methodology adopted is the Object Oriented Technique to develop the e-GP system. With respect to industry standards, Unified Modeling Language (UML) approach can be used to capture the system requirements and design [11]. The e-GP system suggested proposes developing a web based application. The front-end side implemented using HTML (Hypertext Markup Language) and JavaScript while the back-end side implemented in Hypertext Preprocessor (PHP). The database management system is MySQL and the web server as the Apache.

System Design

1) A Graphical User Interface sub-system can be implemented that uses different user interface components which will consume web services. These may include:
   a) A User Interface client module running on desktop computers. As GUI-based applications provide rich user interface elements and interactions and is often used by purchasing personnel working from their desktop inside a company as suggested by Chein and Meixell.
   b) A browser-based application can provide an easy access to the e-Procurement system as long as a connection to the internet is established. Web presentation layer components are web programs running on the server-side.
   c) Mobile clients. Mobile device such as cell phones, personal digital assistants (PDAs) can consume Web services. Special micro-browsers can be used to get access to a server-side Web program. The mobile web programs need to render Web pages in formats such as WML or HTML that are appropriate for the requesting mobile devices [Chein & Meixell, 2011].

2) E-Procurement Agent: The e-Procurement agent is a software sub-system component implemented in Web services. It serves as middle -tier component to handle the interactions with the Web Services Registry and with the Web browser clients. The e-Procurement Agent is implemented as Web services to be consumed by the front-end user interface applications

3) Servlet Web Interface Module (SWIM) implements the Web interface for the system. Users use the Web browser to communicate with the system while SWIM establishes the communication and interchange information between the system and the users through the Web browser [14]. It maintains and controls the flow of data between the user and the system. SWIM is based on Java Servlets Technology. Servlets are applications running on the Web server to manage client's requests [14]. The communication between the Web browser (clients) and the Apache Web server is over a Secure Socket Layer (SSL) i.e. HTTPS[15]. Since the system is multi-users system, there is need to manage individual session achieved with the help of Servlet session tracking . When a user makes a request, a session ID is created for the user, which identifies the user throughout user interactions with the e-procurement Agent.

4) The system database consists of data and facts about the clients (suppliers and procurement Entities) together with rules governing procurement procedures. We used relational database for the persistence layer as stated above but the programming language used is object-oriented. The Database Interface Module (DTIM) implements the object-oriented interface for the relational database.   DTIM uses Java Database

Connectivity (JDBC) [Dada, Kochs, Peterson, et al] for connection into the database.
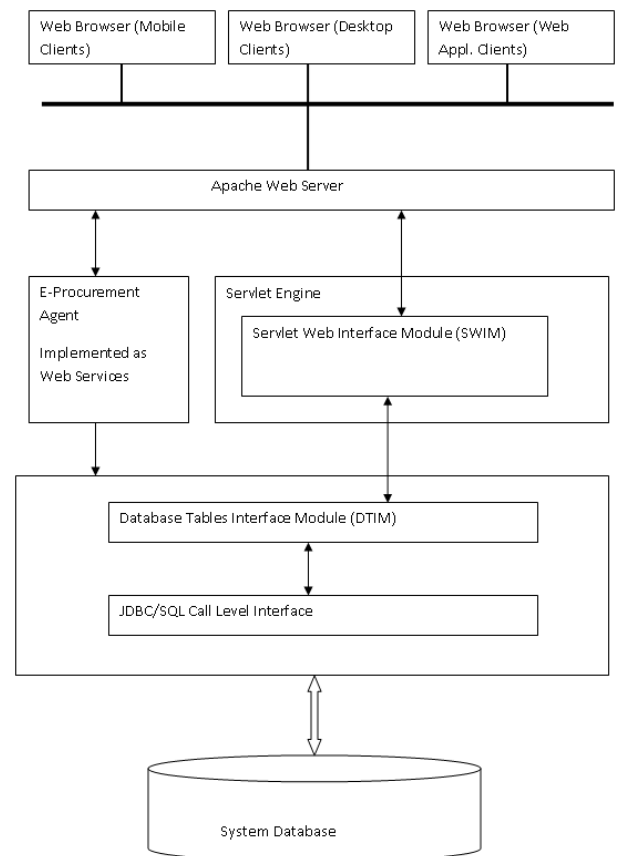

Figure 1: Architecture of e-GP System

E-GP System Modeling

Modeling is a technique used to represent complex systems at different levels of abstraction, and helps in managing complexity of design in computer based systems. UML is an object-oriented language that can be used to model object-oriented systems. It is possible to use UML to model web applications by using extensions supported by UML [Emad Goshes et al]. Conallen proposed an extension of UML for web applications.

Class Diagrams are used in UML to model a collection of objects with similar attributes and behaviour. The e-GP System prototype has identified a user, Procurement entity, contract, supplier and e-GP system database as classes in the e-GP System. Each of these classes has a relationship with one or more of the other classes. Procurement Entity and Supplier have an inheritance relationship with a User class. A special kind of aggregation referred to as composition relationship exists between the procurement entity and e-GP system Database, e-GP System Database and Supplier and between supplier and procurement entity. Figure 2 below shows such a scenario.
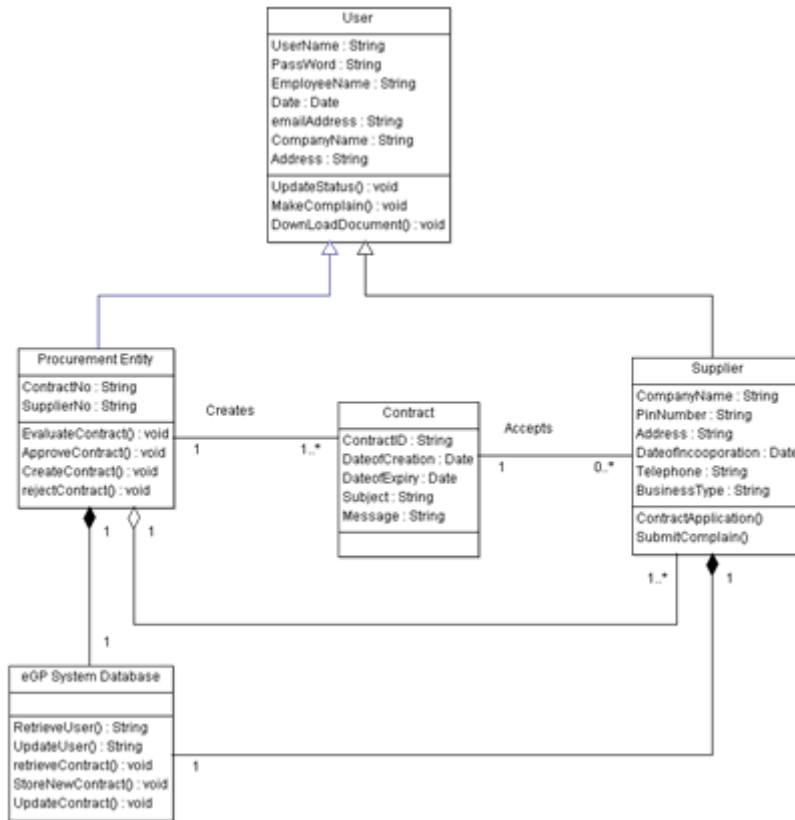
Figure 2: Class Diagram for the e-GP System

A use case is a methodology used in system analysis to identify, clarify, and organize system requirements. It shows the boundaries under which a system operates. The use case is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal. It consists of a group of elements (for example, classes and interfaces) that can be used together in a way that will have an effect larger than the sum of the separate elements combined. The use case should contain all system activities that have significance to the users. Figure 3 below shows a sequence of interactions between the systems and user in an e-GP web portal environment.
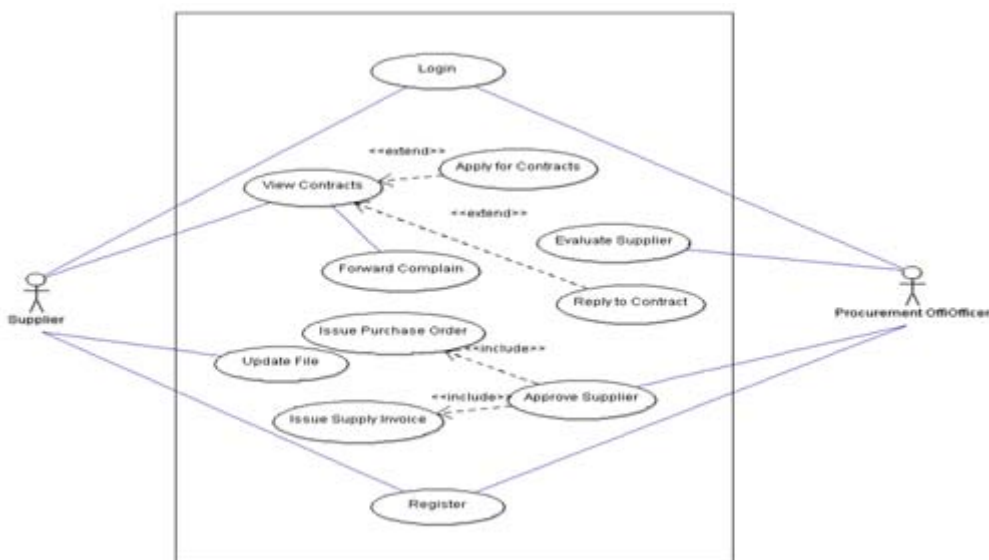

Figure 3: Use Case Diagram for the e-GP System

A state diagram is used in computer science and related fields to describe the behavior of systems. State diagrams require that the system described is composed of a finite number of states. State diagrams are used to give an abstract description of the behavior of a system. This behavior is analyzed and represented in series of events that could occur in one or more possible states. Figure 4 below describes the various events used to describe state and behavior of an e-GP System.
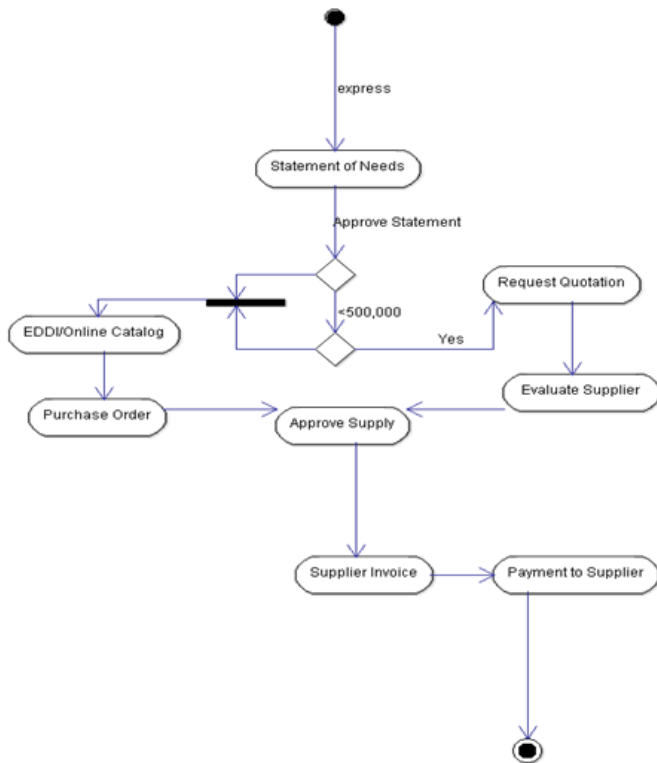

Figure 4: State chart for the e-GP System

SUMMARY

The desire for accountability and transparency in government operational activities is great amongst the Kenyan population. Freedom of information is a driving force to a free market society that encourages fair competition. With the advent of the internet, information has readily been available and people have been able to choose and make better decisions. Development of an electronic Government Procurement Systems (e-GP) can lead to improvement in management of government procurement processes, thereby ensuring transparency, monitoring, control, fair selection of bidders, reduced cost of transactions and increased efficiency. A well functional e-

GP system for the Kenyan can in future encourage fair competition amongst countries in the regional trading blocs of COMESA and the East African Community.

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