WEB BASED ELECTRONIC-PROCUREMENT SYSTEM:
A CASE OF BINDURA UNIVERSITY OF SCIENCE EDUCATION (BUSE)

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Dedication

This research is dedicated to my brilliant, outrageously loving and supportive parents, not forgetting my always encouraging and ever faithful relatives. I am forever indebted to your love. I thank you for all the support and believing in my dream, may the good Lord continue to bless you all.
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Abstract

In developing countries, public procurement remains a topic of interest because of its nature that revolve around transparency, fair, honesty, cost effective, competitiveness and accountability pillars. In developing countries like Zimbabwe, procurement must align to the Public Procurement Act to meet the pillars mentioned above. The emerging of e-procurement has paved way for business institutions to be able to cope with increase in demand for resources. It is because e-procurement systems thrive to improve the purchasing processes as well as collaboration between trading partners. Likewise, Bindura University of Science Education (BUSE) as a government institution must adhere to the Act stated above.

BUSE has five geographically isolated campuses, with different departments at each campus. Because of this isolation of campuses and lack of e-procurement system, that integrates internal as well as the university with its suppliers; it has become a major challenge for departments to acquire resources in a timely manner. The lack of e-procurement system is also associated with high costs. Henceforth, this study proposes that the use of web based e-procurement system by BUSE departments in purchase operations, which include making a purchase request, supplier evaluation, purchase orders, delivery and payments, helps to solve the problems being faced by these departments. This is possible since the web based e-procurement system is capable of integrating BUSE with its suppliers.

Furthermore, this study will give a comprehensive literature review on earlier existing procurement systems. A research methodology called Dynamic System Development Model (DSDM) will be used during this study. The researcher used stratified sampling during the survey to assess on usability, functionality and performance of the proposed system. More information on data collection methods used during the study, that is questionnaires, interviews and observations is given. Data collected was analyzed with Statistical Package for Social Sciences (SPSS) to observe realism in the design of the real system. Results obtained were discussed and presented on tables, simple bar graphs as well as clustered bar graphs, which shows corresponding frequencies and percentages. The dissertation concludes with conclusions and recommendations on future work.
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Chapter 1: Problem Identification

1.1 Introduction

(Sarpong, Jianguo, Khan & Acheaampong, 2017) states that with present dynamic global competitive business environment, technology based service is no longer an afterthought; rather it is necessary for public and private organizations to clinch for its greatness. By embracing this technology, it has led to continuous development and growth of institutions. Due to growth of organizations, there is need for procurement methods also to expand accordingly. With this, it has paved way for the adoption of e-procurement systems at the expense of traditional mode of procurement, since traditional systems failed to meet the need of resources of modern business processes. Therefore, to leverage government institutions like universities to greater heights, support of day to day operations and demand, then procurement has to be done efficiently and effectively. To achieve the above, universities need to implement web based e-procurement system because it ensures a good tradeoff between demand from internal clients and time it takes the external clients to meet the required demand.

Traditional procurement systems are associated with time consuming, costly and inefficient procurement processes such inefficient generation, tracking of purchase requisitions and purchase orders, unfair choice of suppliers, and repetitive tasks which difficult to control. Hence, efforts to solve problems associated with traditional procurement system were put forward. Noted efforts started with the development of Electronic Data Interchange (EDI), which is a platform used to exchange of electronic business documents in a standard format between two business entities (Asher, 2007). Later, the above was replaced by Enterprise Resource Planning systems (ERPs), which seek to integrate business processes with purchase management. (Umble, Haft, & Umble, 2003). The forthcoming of web based procurement systems focuses on covering gaps associated with above-mentioned systems. This chapter outlines the need to implement of a web based e-procurement system for Bindura University of Science Education (BUSE).

1.2 Background of the study

All government institutions must align their procurement process to the Public Procurement Act of Zimbabwe when acquiring goods and services (‘Public procurement and disposal of public assets act 22:23’, 2017). Likewise, BUSE as a government institution follows this Act. However, the process is affected by geographical isolation of the university’s campuses. BUSE has five (5) campuses fragmented according to faculties, with each faculty having more than one department
where the need to procure arise. The administration offices are at main campus, where purchase requests are processed. Currently the procurement process is a devolved procurement model whereby some individual departments place purchase requests with suppliers of their own choosing for goods and services as and when they are required. Besides, it also partially uses an electronic system called Sage Pastel package. This system is only used by the procurement office to manage purchase orders and tenders only. This is because of high costs and its off-the-shelf product nature, which makes it impossible to customize to suit the needs of various departments. When the need to procure arise, the departmental secretary fills in a purchase request (PR) form and is authorized by head of department (HOD). Afterwards it is posted to the bursar for approval, where he or she checks if sufficient funds exist in the department vote. Once approved the buyer starts processing it. 

Firstly, buyer solicit at least three (3) quotations by sending scanned copies of Request for Quotation (RFQ) document to suppliers via e-mails. Supplier respond with a quotation that is used to create comparative bid analysis document (CBA). Using agreed evaluation criteria factors on the CBA document, such as compliance to specifications, payment methods, valid tax clearance and price the best supplier is selected and awarded the contract to supply. A purchase order (PO) document is created for the selected supplier, approved by the bursar and scanned copy is send to the selected supplier, stores and HOD via email. Follow-up of suppliers is done by stores clerk through the use of emails and telephone calls. Usually the supplier is given 7-12 days (maximum) to deliver the order, failure to do so the contract is terminated and process is restarted. The delivery is checked for correctness and if the invoice matches the PO and goods received note (GRN) document by stores clerk. The bursar makes payment and sends proof to the supplier. Lastly, the buyer prepares monthly reports. 

However, time consuming, costly and repetitive processes characterize the above method. Tracking of procurement related documents is difficult since they move from desk to desk in various offices. In the event of a delay, one may end up travelling to main campus for clarification. In addition, cases have arisen where some PR forms have been reported missing or misplaced during the office circulation for approvals, for example recently in September 2017, BUSE procurement reported a PO document for laptops was lost whilst in circulation. This indicates that if the procurement processes are not handled properly, it may lead to duplication of work. (Augustine, Rehan and Omwenga, 2017) highlights that companies that use e-procurement
technologies can save 42% in purchasing transaction costs due to the simplification in the purchase process and reduction in purchasing cycle time. Therefore, there is need for transition to a web based e-procurement system.

1.3 Statement of the problem
The existence of isolated campuses at BUSE where different departments are located is a major concern to all clients who need to make purchase requests at the university. Currently, the procurement process at the university is centered on a devolved procurement model whereby some individual departments place purchase requests with suppliers of their own choosing for goods and services as and when they are required. Purchase related documents are circulated from desk to desk for approvals making tracking to be difficult. It also lacks the ability to integrate departmental procurement needs with the buyer and supplier; hence, it is associated with time consuming, costly, inefficient and repetitive procurement processes. Inefficient processes are biased in selecting the supplier, poor supplier collaboration and poor procurement progress tracking. Therefore, by developing a web based e-procurement system it will reduce the time it takes to solicit, evaluate supplier, deliver order and make payment easy.

1.4 Research Objectives
To help address the research project the researcher has come up with the following research objectives:

1. To design and develop a web based e-procurement system for Bindura University of Science Education.
2. To assess the effectiveness with respect to time of web based e-procurement system in the acquiring of resources by departments.
3. To evaluate the web based e-procurement system on usability, functionality and performance.

1.5 Research Questions
This research sought to answer the following questions:

1. What are the reasons for developing a web based procurement system for BUSE?
2. How does the web based e-procurement system improve the process of acquiring resources by departments at BUSE?
3. Can people gain an insight on how the system works and convinced to opt for a full functional system?
1.6 Research propositions
Null Hypothesis ($H_0$): There is no significant difference in the use of a web based e-procurement system to improve efficiency or time being taken by departments acquire resources as compared to the current system at BUSE.
Alternative Hypothesis ($H_1$): There is a significant difference in the use of a web based e-procurement system to improve efficiency or time being taken by departments acquire resources as compared to the current system at BUSE.

1.7 Significance of study
Electronic procurement systems reduce purchasing cycle time, lower the inventory levels, reduce the administrative and instead they enhance performance of suppliers. (Son and Benbasat, cited in Tirkkonen, Hallikas and Schiele, 2017).

Basing on the inspiration above, organizations need to streamline their procurement processes to the modern web based e-procurement systems. The reason is that it allows various needs of departments to be met in timely manner. Also there is better supplier-buyer or buyer-department collaboration by sending sms notifications, easy procurement progress monitoring handle their procurement needs in an efficient manner. There is maximized supplier and buyer collaboration with departments done by sending sms notifications and easy procurement progress monitoring via tracking reduces time of purchasing.

A web based e-procurement system is an innovative solution aimed at eliminating biasness in supplier evaluation. It will allow easy integration and collaboration of BUSE to its suppliers. Demands of greater convenience and accessibility are reflected in no longer relying on doing walk-ins to suppliers or offices to get or deliver documents. The system can provide complete flexibility of acquiring, sourcing or checking for payments or delivery, whilst in the comfort of your office. The web based procurement system has the potential to be a more usable and reliable system than the manual system.

1.8 Assumptions
i. Bindura University of Science Education has departments that are in possession of high performance desktop computers and an active internet.
ii. Personnel at departments of the university have high level of literacy.
1.9 Limitations
Some of the literature on the area of study was scarce, therefore the researcher had to manually research on how some procurement systems work. Most literature focuses on why other organizations successfully or failed to adopt e-procurement systems instead of giving the information on how other systems facilitates procurement. Moreover, the researcher was not familiar with the subject matter of the study area, hence extra effort was required to learn more about procurement so that the proposed system could be designed and developed. Besides, large sample was limited to employees of the university. It was necessary due to time and resource limitation factors.

1.10 Delimitation of the research
The study will mainly focus on Bindura University of Science Education (BUSE) in particular. The product in this study is a web based e-procurement for BUSE. Since the software is intended to be used by BUSE, large sample was limited to employees of the university. The system will first be implemented at Computer Science department. Once this prototype is assessed and is found to be successful, this system is suitable to be implemented for all departments since it can be scaled. Details of all the stakeholders will be stored in a centralized database and managed by a system administrator.

1.11 Definition of terms
Procurement – is the process of finding, agreeing terms and acquiring goods and services from external source.
Purchase order – is a commercial document which is issued by the buyer to a supplier indicating details such as item description, quantities and agreed price for products.
Purchase requisition – is an internal document that is generated by a user department to notify the purchasing department of items it need to order, its quantity, preferred supplier and timeframe.

1.12 Chapter summary
This introductory chapter gives a foundation on the area under study and its background, clearly defines the problem which needs to be addressed and reasons why it is important to tackle it. All the work to follow will be guided by the aim and a set of objectives discussed above. After all this groundwork, this chapter is followed by literature review, methodology used, data analysis and results as well as recommendations and brief conclusion to the study.
Chapter 2: Literature Review

2.1 Introduction

(Kumaraswamy et al., 2004) argues that due to improvements of the technology and internet, noticeable is a sharp rise in the use of modern e-procurement systems. Many government institutions such as universities are now utilizing modern e-Procurement systems to achieve smart and sustainable growth objectives. Henceforth, this paper will critically assess e-procurement systems and furthermore investigate the literature on the conceptual framework of various existing e-procurement systems. The classifications of this system will be condensed into the traditional procurement systems and electronic procurement system. Brief yet detailed information shall be provided on strengths and gaps of these classifications. This chapter will also allude to literature, which supports the choice of software development methodologies, programming language and system testing to be used before it concludes with a chapter summary.

![Procurement process overview](image)

*Figure 2.1 Procurement process overview (Noraziah, Peszynski, Azizan & Sundram, 2016).*

2.2 Relevant theory of the subject matter

The review of related literature will be mainly focus on trying to answer the following questions:

- What are current systems being used for procurement worldwide?
- What are the existing systems about electronic procurement?
- Why study the research problem further?
- What contributions is the present study expected to make?
2.3 Classifications of procurement systems

Below are various categories of procurement systems on which more details will be given in quest to answer the questions that have been stated earlier.

2.4 Traditional Procurement Systems

(Hartnett & Hefferman, 2001) found out that this system was modelled in a way that departments place purchase requisitions with suppliers of their own, choosing goods and services as and when they are required. These procurement documents were circulated from office to office physically or by using scanners, e-mails and enhanced fax. (Attaran, 2001) argued that estimated costs incurred by using such a system ranges from $50 to $200 every time it is used. For example, buying a PC involves so many steps and with a paper-based, it takes from one day to forever. Besides it being favorable for auditing and easy handling purposes, it is associated with time consuming, costly and inefficient processes. Its gaps are inefficient procurement documents creation and tracking, biasness in selecting the best supplier, lack of supplier collaboration and repetitive of tasks.

2.5 Electronic procurement system

(Madhusudan & Manjunatha Rao, 2016) defines e-procurement as a way applied by the user to purchase the products or the services online. (Zunk, Marcher, Uitz, Lerch & Lerch , 2014) defines it as the streamlining of procurement processes by eliminating paper-based documents, as all the purchasing processes are moved to a web based application. An e-procurement system can be deduced as any technology designed to facilitate the acquisition of goods by an organization, while integrating purchase management between the end users with buyer as well as between buyer and supplier. This system was designed to address the weaknesses of a traditional procurement system.

2.5.1 Electronic Data Interchange (EDI)

History articulates that an EDI is the first electronic supply chain management (SCM) software, which was used to facilitate external purchasing and strengthening supplier collaboration. It was meant to simplify communication between the trading partners by replacing procurement documents with electronic versions which had a standardized format and syntax (Khan, 2016; Tirkkonen et al., 2017). During transfer, EDI documents only with X12 and XML format were transferable using Applicability Statement 2 (AS2) and Value Added Network (VAN). AS2 provided a direct node to node connection whereas VAN acted as a virtual mailbox that different companies can connect to send or receive information (Khan, 2016).
At the buying side, the generated PO was passed to the EDI software, where the internal data structure was converted into a transaction with required fields supplied by the data dictionary. After the conversion, the transaction was sent to the supplier’s EDI where it was converted to a format accepted by their order processing system. During transportation to suppliers, EDIs does not transmit exact copies of documents. The diagram below summarizes the process:

![Diagram of EDI process](image)

*Figure 2.2 Overview of how the EDI worked (Khan, 2016)*

2.5.1.1 Strengths of EDI

(Subramani, 2004) as summarized in (Tirkkonen, Hallikas, & Schiele, 2017) noted strengths of reduced cost, faster response and improved client service in EDIs. Other benefits noted was no rekeying of data thus reduced errors and elimination of paperwork (Lou et al., 2015). The aspect of trading partners sharing business documents was the main strength in EDIs.

2.5.1.2 Gaps Noted in EDIs

(Asher, 2007) noted difficulties of high implementation costs, high data transmission costs, difficulty in keeping up with standards, difficulty in establishing audit trail, rigid message formats and need for standardized systems to communicate. Only documents with a standardized format was transferable and the message being transmitted was charged per character. Rigid supplier collaboration as each trading partner was required to own an EDI to communicate with another party for communication. EDIs did not take into account the whole procurement cycle, instead they only had the ability to share purchase orders. Supplier evaluation was not
possible hence, biasness still existed. In addition, it did not have any mechanism to facilitate payment for services. Also it could be integrated with a payment module. Lastly, it did not provide efficient user notification. However, this system was not being adopted by researcher as a solution to exist problem because of its gaps, instead the proposed system will address some of these gaps.

2.5.2 Enterprise Resource Planning (ERP)

(Handfield et al., 2009) stated that ERP systems offer support in data processing and integrating business functions within corporations. Similarly, (Weinrich & Ahmad, 2009), as summarized by (Rajan & Baral, 2015) defined it as a systems that integrates a number of business processes, such as manufacturing, supply chain, sales, finance, human resources, budgeting, and customer service activities. ERPs integrates various business processes of different functional areas with purchase management. This is done through a shared database, which allows people to work on same data. The research reviewed on two types of ERP software, which are System Applications and Programs (SAP) and Sage Pastel E-business.

2.5.2.1 SAP Net Weaver and the MM Module

Systems, Applications and Products (SAP) plays an important role in data processing, as it offers high level of integration amongst its individual application to guarantee consistency of data throughout the system and the organization (More, Gudi and Nayak, 2014). SAP Net Weaver is a GUI (Graphical User Interface) for windows operating system or desktop application, which consists of three embedded suites namely SAP Business Suite, SAP ERP and SAP Customer Relationship. A complete SAP system has 12 modules, with Materials Management (MM) module being part of these modules used to support procurement by providing top management information on reorder levels and purchase order management.

2.5.2.2 Sage Pastel E-business

(Filed, 2015) defines Sage Pastel as an ERP solution that brings about all the aspects of operating environment together, giving businesses the ability to control financial situations, customer, supplier and employees’ relationship. It mainly comprises of accounting modules, but it also facilitates procurement through such as General Ledger, Cashbook and three more. Besides, it also facilitates procurement through a few procurement modules such as Sales and Purchasing order entry module, Inventory control module, Advanced Procurement and Delivery management modules.
2.5.2.3 Strengths noted in ERPs

In ERPs, data is collected once. This allows users to work on the same data, which means there are reduced errors and data redundancy. ERPs operates in real-time environment, this means that information is available to functional areas to support their respective operations within a reasonable time. Modularity in ERPs allows deployment of some modules needed by an organization at any particular point in time without affecting operations. Share information, cut back costs, improved management of business processes (Altamony, 2016). Other potential benefits include reduced costs, ease of access to global innovations and scalability. Standardized off-the-shelf packages that if implemented can deliver benefits such as integrated best practice processes, efficient business processes, real-time access, visibility and accuracy of information (Seethamraju, 2017).

2.5.2.4 Gaps noted in ERPs

Cost of adoption by SMEs is high, ERPs requires investment in hardware infrastructure, software package and licensing and implementation is time consuming, costly and risky extensive business process changes (Seethamraju, 2017). They are expensive since maintenance of user profile is required and cost over $1500, for an individual license that expires at the end of every annual. It is an off-the-shelf product, despite its modularity; it cannot be customized to suit the need of a particular department. Soliciting is done manually, for example, SAP Net Weaver and Sage pastel does not support sourcing, instead used for tender, purchase order and inventory management. Most ERPs lack workflow streamlining to support authorization processes. They also lack supplier evaluation and no efficient buyer-supplier collaboration. Most ERPs were designed to support top management with decision making. This system will not be adopted as the solution to the problem because of the above-mentioned gaps it is associated with.

2.5.3 Web based e-procurement system

Tirkkonen, Hallikas & Schiele (2017) defines this system as a platform that allows buyers and suppliers to interconnect and share information and knowledge using the Internet and web browsers. A web-based e-procurement system is a website that automates the buying cycle, optimize spend, improve process and workflow, support bidding and tendering and facilitate more effective search for resources (Smart, 2010). In other words, a web-based platform integrates functional areas with purchase management (suppliers included). A system of such caliber can be customized to suit the needs of any functional area at any particular point in time.
2.5.3.1 Integrated Production Management System (IPMS)

Integrated Production Management System (IPMS) handles complete life cycle starting from procurement till delivery (More, Gudi and Nayak, 2014). It was mainly developed to support procurement of resources during car manufacturing industries, since it has an inventory management. IPMS consist of other sub-modules such as the order-tracking module for tracking progress for orders in real-time. It lacks sourcing and supplier evaluation capabilities; hence there is biasness during awarding of supplier contacts. Soliciting is only limited to the manual way, which is costly and time consuming.

2.5.3.2 Strengths of web based e-procurement system

(Kumaraswamy et al., 2004) identified strengths of real-timed collaboration with suppliers; this increases procurement process efficiency and reduces cycle times. Besides, it reduces paperwork thus decreasing possibilities for human errors, reduces workload and related costs.

2.5.3.3 Gaps noted in web based e-procurement system

Most web based systems support e-commerce functions through bidding and e-catalogues. They make use of informal supplier evaluation such as ‘the highest bidder get service’. They lack efficient collaboration and sourcing modules, hence support general buying and selling of individuals. There are no sms notifications sent to alert on jobs that needs to be performed. This can be seen from web-based systems like Amazon and Bid or Buy.

2.5.3.4 Justification on the adoption of web based e-procurement

The research intends to adopt this system type of procurement system because it reduces inefficiency and time to acquire resources by making use of tracking and choosing the best supplier during evaluation, despite supplier’s view of pending sms notifications for different reasons to eliminate idleness. has the ability to strengthen the collaboration of an organization with its suppliers via sms notifications. In addition, it can be customized to suit any needs of the organization at any particular point in time.

(Kakwezi & Nyeko, 2010), as summarized by (Tirkkonen et al., 2017) highlight that it is difficult to notice the monetary value associated with procurement especially when an institution is using a traditional system because of countless reasons mentioned earlier on the traditional system classification. Lastly, it is possible to monitor spending and procurement activities taking place.
2.6 Summary of findings on gap analysis

In summary, the literature that discusses more on earlier related work is scarce. Most findings focus on why organizations should adopt e-procurement systems and why others are failing to take a competitive advantage of these systems.

As part of findings, the researcher noted that EDIs lacks the functionality of choosing the best suppliers from a given pool. EDIs did not have the ability to solicit required documents from suppliers. In addition, inefficiency existed since buyer-supplier collaboration was not supported by the use of sms notifications. They used standardized format of documents and messages are charged per character, thus costly.

With ERPs, SAP Net Weaver GUI and Sage Pastel, they do not support sourcing, since they require both trading partners to be operating on the same platform. Besides, they do not account for supplier evaluation, decision on contract awarding, supplier notification using sms and e-workflow for approval. ERPs cannot be customized to suit the need of a particular department because it is an off the shelf product. Lastly, most of them requires investment in hardware infrastructure, software package and licensing and implementation is time consuming, costly and risky extensive business process changes.

Most web based e-procurement systems such as Amazon support informal procurement, as a Procurement Act governs public procurement in institutions. It is within this document where the evaluation criteria factors used in selecting the best supplier are laid. Unlike in other web based system they use evaluation criteria such ‘the highest bidder gets the service’. Lastly, most of them do not send sms notifications to alarm suppliers on pending jobs.

2.7 Software Methodology

Research indicates that most traditional development methodologies are based on old-fashioned concepts which can be traced back as far as 1970s (Howcroft and Carroll, 2000). Many modern software methodologies can be used in developing projects. (Burback, 1998) defines software methodology as the body of methods, rules and processes that are used to manage a project. In a project, people are guided by common goals and strategies that demands the support of tools and software methodology to produce an end. In chapter three, the researcher will consider Dynamic Systems Development Method (DSDM), which is an agile software methodology technique. All agile techniques focuses on simplicity and speed during development which will help in producing the deliverables in stipulated time frame (Raja, 2016). The researcher used this technique because
of existence of interaction of processes over tools, working software over comprehensive documentation, customer collaboration over contract negotiation and its ability to respond to changes over following a plan.

2.8 Programming language

Nowadays, most websites that are not hand-crafted but are made using programming languages such as PHP, ASP, Perl and Python (Castillo, 2002). These languages attempt to make web pages’ dynamic as opposed to early days where shell script was used to generate server-side. During the research, the researcher used Personal Home Page (PHP) language, HTML code and JavaScript. This is because the above languages are dynamic scripting languages used to design dynamic websites and they are most common and easy to understand. More information is given in the next chapter.

2.9 System testing

This section focuses on the literature of methods that were used for testing the web based e-procurement system in chapter three (3) after development. Testing is a way off finding errors from a software system (Jan et al., 2016; Mahmoud, 2016). Software testing helps to identify and debug mistakes or errors to come up with a quality software. The main testing methods are black box testing, white box testing and user system testing (Jan et al., 2016) and the researcher used them to test the web based e-procurement system. With black box testing it checks whether all input needed by the system is accepted in specified manner and gives out the correct output (Mahmoud, 2016). There is no need to have knowledge of the source code. Unlike with white box testing where the focus is on investigating the internal logic and structure of source code. System testing performed by various user of the web based e-procurement system to verify if the system is properly integrated and able to perform intended functions.

2.10 Chapter Summary

Web based e-procurement system centralizes and integrates all departments of the university and procurement processes. It can be customized to suit various needs of a functional area unlike ERPs and EDIs. It is associated with benefits such as reduced time, reduced costs, faster transaction and processing of information. The next chapter will give a brief description of how the system was designed and how the project was carried out.
Chapter 3: Research Methodology

3.0 Introduction

A research methodology can be defined as a systematic way to solve a problem and its primary goal is to give a work plan of the research (Choy, 2014; Bodla, 2009). Likewise, it is organized around operational steps that form research process for both quantitative and qualitative research (Kothari, Kumar and Uusitalo, 2014). This chapter serves as a blueprint of how the research was carried out in order to achieve objectives of the study. Besides, it elaborates more on the qualitative and quantitative techniques used for collecting data. To be able to attain the research objectives, the author used diverse research instruments to gather information that supports the area under study. Furthermore, this chapter outlines the software development methodology used during system development, data collection methods and analysis, population and sample, functional and non-functional requirements, and system development tools that were used by the researcher.

3.1 Research Designs

A research design, in the view of (Rotich, 2015) is an overall blueprint for measurement and analysis of data. It is an overall plan that connect the conceptual research problem to the achievable empirical research. Equally, it is a plan that is carried out to find answers to various research questions. As a result, a proper design was modelled in-order for the project to become a success, since it is a way for one to arrive at valid findings, comparisons and conclusions.

It also entails the technical details on the approach used to implement the system and reach the solution. The main objective is to design a web based e-procurement system that will help to acquire goods in an efficient and timely manner. The effectiveness of the system was determined after various users put the system under test and it was calibrated according to the user feedback. This process involved sampling from the target population and carrying out an investigation. Below are the steps or procedures which were followed:

- The target population was divided into experimental groups based on job designation.
- Secretaries, Head of departments, buyers, the bursar, stores clerk, Information Communication & Technology (ICT) administrators and suppliers were the experimental group since these are people who are directly involved in procurement.
- Stratified sampling technique was used as the researcher engaged into interviews and observations to gather data related to the requirements. Questionnaires were administered to these groups for user evaluation during system testing.
Collecting of the questionnaires from participants, engage them into short interviews and performing data analysis.

Setting up and configurations of the desktop or laptop computers for the users of the web based e-procurement system.

System testing was performed using black testing (correct input produces intended output), white box testing (verifying the logic in source code) and lastly with system testing (where users verified system components integration and whether intended functions were being performed and record the responses on a questionnaire for evaluation).

Results were collected, recorded and evaluated, using a statistical package called SPSS.

The results determine if the system is effective or not.

3.2 Software development methodology

Dynamic System Development (DSDM), is an agile technique that was used during the development of the system. Raja (2016) defined an agile methodology as a software development method in which requirements and solutions evolve through collaboration between self-organizing and cross functional teams.

3.2.1 Dynamic Software Development Method (DSDM)

DSDM is an agile method which consists of three major phases which are pre-project, project life cycle and post project (Raja, 2016). This method is useful because it is driven by nine (9) principles namely; user involvement, empowering team work, frequent delivery, addressing current business needs iterative and incremental development, allowance for changes, scope fixing before project starts, testing throughout the lifecycle and communication. With these principles this technique becomes naturally fit to be used for development of web based prototypes or applications in a short space of time. Instead of freezing the functionality in a system whilst adjusting time and resources to meet the functionality, it tends to fix the time and resources and then adjust the functionality accordingly. It deals with iterations using a time box approach, which has predefined start and end time period. Lastly, it consists of five (5) phases, in which the first two (2) phases are sequential as well performed only once and the last three (3) phases which focuses on actual development work are done in an iterative and incremental manner. Below are the phases:

3.2.1.1 Feasibility study

On this stage, a decision to choose to use this methodology is done and it is determined by the type of the project, organizational and people issues (Abrahamsson, Salo and Ronkainen, 2002). The
decision is based on the technical possibilities and risks associated with the project. As a result, the researcher conducted the feasibility study which considered the economic and technical feasibility. On the economic feasibility, cost of both study the current system and existing system versus cost of developing and implementing a web based e-procurement system was done. To add on, the researcher also considered the technical feasibility which focused on the costs related to hardware and software specifications, as well as the knowledge and skills of the individuals to use the system. Other feasibility tests carried out includes schedule, legal and operational feasibility. After analysis of these factors a decision was done to proceed with the study. Initial system requirements were gathered.

3.2.1.2 Business Study
On this phase an analysis of business processes and its current technology was done. All the system features, development priorities and affected business processes are looked into on this phase (Abrahamsson, Salo and Ronkainen, 2002). The researcher came up with high level description of processes which are flowchart diagrams, use-case diagrams, ER diagrams and system architecture definition. The outcome of the phase was the prototype plan and commencement.

3.2.1.3 Functional model iteration phase
This is the first iterative and incremental phase. All the contents and approach for the iterations are planned, gone through and results are analyzed (Abrahamsson, Salo and Ronkainen, 2002). The researcher started developing the prototype of the web based e-procurement system using various software development tools. Functionality of the prototype were not discarded as they were necessary in coming up with the final prototype of the system. The researcher performed black box and white box tests.

3.2.1.4 Design and build iteration phase
This is the phase where the functional prototype is built by integrating various modules of the prototypes (Abrahamsson, Salo and Ronkainen, 2002). It is iterative. Output of this phase was tested system to see if the least the minimum required set of requirements are met. The prototype was given to users to perform system testing and record their responses on the given questionnaires. The feedback from the users was analyzed and the system was calibrated to meet proposed changes.
3.2.1.5 Implementation phase

On this stage, the system is transferred from the development site into the actual production site (Abrahamsson, Salo and Ronkainen, 2002). At this stage the users are trained and the system is deployed into the operational environment. Suppose there was a lot of users to use the system, then was to be implemented in an iterative manner. If technical issues arise and cannot be addressed due to time constraints, they would be iterated again starting from design up to build iteration phase.

Figure 3.1 The DSDM model (Abrahamsson, Salo and Ronkainen, 2002)

3.3 Population and Sampling

Study population refers to the individuals, groups or communities where data or required information is collected from in pursuit to find answers to research questions (Kothari, Kumar and Uusitalo, 2014). Similarly, Bodla (2009) defines population as the group of elements defined according to objectives of the study. In simpler terms, population is the total number of units under study from which data can be collected. These units can be events or individuals. A sample can be defined as a subgroup of the population one is interested in (Kothari, Kumar and Uusitalo, 2014). Similarly, Alvi (2016) defined it as a group of relatively small number of people selected for investigation purposes.

The researcher used a sample which was representative meaning that the characteristics of the units selected was similar to that of the entire target population. The sample size of the study was made up of sixty-six members some which are secretaries, heads of departments (HODs), buyers, bursars, stores clerks, three ICT (Information Communications and Technology) administrators and suppliers. To extract information from above mentioned population, sampling was done to
come up with participants who represented the entire population. Sampling is a process through which a sample is extracted from a population (Alvi, 2016; Kothari, Kumar and Uusitalo, 2014). The researcher used the stratified random sampling design to come up with samples. According to (Kothari, Kumar and Uusitalo, 2014) states that “this sampling design attempts to stratify the population in such a way that the population within a stratum is homogeneous with respect to the characteristic on the basis of which it is being stratified”. Using the stratified random sampling technique, the researcher considered job title and roles of different staff members at BUSE. Seven groups or strata of varying sample size were created. From sixty-six (66) members of the entire population, only a sample consisting of five (5) secretaries, five (5) heads of departments, three (3) bursars, three (3) buyers, two (2) stores clerks, three (3) ICT administrators and five (5) supplier’s groups or strata were formed. The reason why the researcher deduced this sample was to reduce scope of the system as these users would perform system testing. In addition, the researcher used interviews and observations were carried out with each group to gather which helped to get a picture of how the procurement process is being carried out. Questionnaires were used during system testing by users to give feedback. Outcome of the feedback or results obtained will be clearly given in the next chapter.

3.4 Data Collection Methods
(Evans and Crawford, 2000) views data collection as a strategy that is used to collect information on resource use. The study combined the qualitative and quantitative research paradigms so as to enable more information to be gathered from the sample. Quantitative methodology deals with statistical analysis and numerical data to provide information (Choy, 2014). This methodology was used to evaluate data and mitigate biasness from the researcher point of view (interviews and questionnaires). Validated questionnaires and interviews largely constituted the quantitative methods. On the other hand, qualitative methodology is meant to provide a clear understanding of the procurement process since it is descriptive and narrative (Choy, 2014). Under this method, the researcher used observations for gathering data. Observations were used to gather broader information with non-measurable variables, which is helpful in facilitating data collection process.

3.5 Data Collection instruments
Data collection instruments are tools that are useful in collecting data during a research and they can be structured or unstructured (Turner et al., 2014). Therefore, for the sake of collecting data
the research used these instruments during the study. These tools were questionnaires, interviews and observations. Full details on how they were used is given below.

3.5.1 Questionnaires

(Mathers, Fox and Hunn, 2010) argues that “questionnaires are a useful tool or option to consider when conducting a postal survey “. A questionnaire is a list of research questions asked to respondents and its purpose is to gather information or extra information from the respondents (Aikins et al., 2014). It can be defined as a convenient way of collecting useful comparable data from a population sample. The questionnaires used included both open ended questions and closed ended questions. According to Bodla (2009), open ended questions allows the respondents to answer in their own words whereas closed ended questions requires the respondents to choose from a pool of given set of answers. They had a provision of respondents to tick their answers as well as respond to some with their own opinion. Also the questionnaires were self-administered, thus respondents completed the questions asked without the help of the researcher. They were mainly used during system testing as users gave responses with comparison to other systems. The reasons which justifies why the researcher used questionnaires is because they are economic over other data collection methods especially when collecting data from a large population, less time consuming as these were drafted in a manner that is precise, easy to understand and straight to the point. Lastly these can yield better responses since they assure honest, correct and truthful responses of sensitive questions.

3.5.2 Interviews

According to (Harvey, 2015) an interview is described as series of open questions asked with the purpose of eliciting participants. Equally, it can be defined as a verbal exchange, often done face to face where the interviewer tries to elicit information from other people. The researcher conducted group interviews whereby he engaged seven (7) groups or strata which represents the entire population of the study. According to (Kothari, Kumar and Uusitalo, 2014), a group interview is defined as a strategy in which opinions towards the area of study is explored via free and open discussion between the group members and the researcher. The reason for using group interviews is because of the existence of a number of key departments which engages into procurement. In addition, this group interview was structured. In a structured interview the researcher asks a set of predetermined set of questions, using same wording and order of questions as they appear on the interview schedule or guide (Kothari, Kumar and Uusitalo, 2014). The
research guide used was made up of closed questions mostly. Questions was asked to random selected individuals in the defined strata or groups and responses were recorded.
Reasons why the researcher chose to use interviews is because they are conducted in a face to face manner which helps to provide rich data, explore and understand complex issues or processes useful in developing the web based e-procurement system. Furthermore, they provide instant feedback which allow the researcher to evaluate the validity of the information. The choice of using this tool is influenced by high degree of freedom in controlling interviews and corresponding high response rate. The interview sessions were made short to avoid frustration of the interviewee. On the other hand, this instrument has its own shortcomings such as time consuming and bias between the interviewer and interviewee.

3.5.3 Observations
The researcher conducted pre-observation and post-observation to obtain effective results. An observation can be defined as a strategy that is purposeful, systematic and selective in watching and listening to a phenomenon or process as it occurs (Kothari, Kumar and Uusitalo, 2014). The researcher conducted some observation so as to learn about the processes and system being used by the University, as well as for gathering more information pertaining to requirements where necessary to develop the proposed web based e-procurement system. This observation was non-participatory. With non-participatory observation, the researcher does not get involved in group activities instead he or she remains a passive observer entitled to watch and listen to activities and drawing conclusions (Kothari, Kumar and Uusitalo, 2014). The researcher visited various groups or the defined sample and conducted observations.

3.6 Data Analysis Procedure
According to the researcher, data gathered from questionnaires was tabulated, represented on diagrams such as graphs and pie charts. This data from quantitative research design method was analyzed using descriptive statistical analysis. On the other hand, the simplest way of analyzing qualitative data was done using observer impression. This is when the observers examine data, interpret it by forming an impression and reporting their impression in a structured form. The qualitative data was edited for completeness, consistency, and duplication and then represented in graphs and charts. The Statistical Package for Social Sciences (SPSS) software will be used for data analysis and result will be presented in the following chapter
3.7 Requirements specification

A software system utility is essentially determined by both its functional and non-functional requirements (Lawrence Chung and Leite, 2009). This subsection describes how the system should react to particular inputs and how the system should behave in particular situations are described in the functional and nonfunctional requirements sections outlined below.

3.7.1 Functional requirements

Functional requirements are responsible to represent what the system is capable of in terms of available features (Veleda and Cysneiros, 2015). These define the operations, events and activities that a system is intended to perform without physical constraints being considered. The primary features of the systems are:

- The system should be able to authenticate and authorize users on the network.
- The system must be able to provide users with different views according to their different roles.
- The system should enable secretaries to create requisition, view status and edit requisitions.
- The systems should enable Heads of departments to create requisition, verify requisitions and to approve or edit it.
- The system should allow the buyer to send request for quotations, generate a comparative analysis document and generate purchase orders.
- The system should allow bursar to approve purchase requests, purchase orders and check balances for all departments.
- The system should be able to select the best supplier.
- The system should be able to send sms notifications.
- The system should allow the supplier to generate and send invoices to stores clerk.
- The system should allow the stores clerk to approve delivery.
- The system should allow the bursar to make payments and send proof of payment.
- The system should be able to generate reports for the buyer.
- The system should allow the administrator to manage users.

3.7.2 Non-functional requirements

(Veleda and Cysneiros, 2015) states that nonfunctional requirements are known to represent quality attributes. These quality attributes include privacy, performance, usability, availability, security, scalability and deployment of the system. Importantly, these requirements should cater for
maintainability and testability. Also it should allow the system administrators to find, alter and fix a problem.

3.8 System development tools

3.8.1 Hardware design
The researcher used the following hardware:

i. Desktop or laptop: the system was developed on a laptop which acts as a platform for programming and website hosting process. It is also used by users to access their respective procurement views.

ii. Mobile Phone: mobile phone is the hardware used by the supplier to receive notifications of contract which he or she might have been awarded.

3.8.2 Software development tools
The researcher used the following software:

i. XAMPP: is the local-server to be used for hosting the website.

ii. Sublime text 3: is a text editor which was used for coding.

iii. PHP (using Laravel framework): is a server side scripting language which was designed for web development as well as for general programming purposes. Its code is interpreted by a web server with a PHP processor module which then generate the requested web page. Also is can be embedded into an HTML source code.

iv. HTML: stands for Hyper Text Markup Language. As its name suggest, it is a markup language used for structuring and presenting contents on a web page. It is used to tag files so as to come up with the desired font, color, graphic and hyperlinks on a web page.

v. JavaScript (using Vue Js framework): is a high-level language which is dynamic and interpreted. It is used within HTML web pages.

vi. MySQL: the best relational database management system (RDBMS) being used for developing web-based software applications. It has the capability to run as a server and provides a multi-user access to a number of databases.

vii. NowSMS Gateway: SMS and MMS gateway server software that supports a wide range of SMS protocol.

3.9 Development of the system
The detailed information below will give an overview on how system works.
3.9.1 Use Case

Use case diagrams describes interaction scenarios in a relatively standard format (Davis, 2017). Many software organizations use UML notation to convey the requirements and design of their software projects. Same applies, (Nassif, Capretz and Ho, 2010) states that use case diagrams are used to represent the requirements of the system. These diagrams are composed of use cases and actors. In simple terms, use case diagrams shows how a user interact with the system or represent functional requirements where an actor is a role played by a user. The use case diagram below shows the interactions between the system and secretary, HOD, buyer, supplier, store clerk, bursar and administrator.

![Use case diagram which shows how users interact with the system](image-url)
3.9.2 Flow chart for E-Procurement System

Figure 3.3 The flow chart showing various stages during information or data processing
3.9.3 Screenshots for E-procurement system

Figure 3. 4 Overview of buyer’s dashboard

Figure 3. 5 Overview of administrator’s dashboard
3.10 Chapter Summary

This chapter gave an overview of the research methodology adopted for this study which was centered on the research design, data analysis procedures, sampling techniques, data collection techniques and presentation of data. The overall purpose of this chapter is basically to describe how the researcher managed to tackle the research objectives. The next chapter more details on data presentation and analysis.
Chapter 4: Data Presentation, Analysis and Interpretation

4.1 Introduction
After a giving a brief theoretical background in methodology chapter, focusing on data collection procedures and how data will be analyzed, this chapter at large focuses on aspects of presentation, analysis and interpretation of data obtained. The above mentioned aspects are important since they will address the key areas of the research questions and objectives of the study. Primary data extracted from questionnaires was analyzed and suitably presented, as well as interviews and observations used during data collection of the study.

4.2 Analysis and Interpretation of results
This section focuses at analyzing questionnaires which were distributed to the sample which constituted of seven (7) groups namely; secretaries, heads of departments (HODs), buyers, bursars, store clerks, ICT (Information Communication and Technology) administrators and suppliers. Questionnaire was the primary research instrument which the researcher used for data collection and to some extent from interviews and observations. As shown by the questionnaires attached at the end of the document, key questions were divided according to system usability, system functionality and system performance. All the key questions will be treated separately and an analysis table or graphical representation will be produced. Similar questions from various questionnaires were all analyzed at once for different users. Statistical Package for Social Sciences (SPSS) is the software package which was used to analyze data from questionnaires.

4.3 Analysis of respondent’s questionnaires
A combined questionnaire was responded to by the various groups; secretaries, heads of departments, bursary, buyers, store clerk, suppliers and ICT and the responses were recorded in table 4.1. Henceforth, shown in table below is the response rate of various target groups.
<table>
<thead>
<tr>
<th>Target group</th>
<th>Questionnaires sent</th>
<th>Response received</th>
<th>Response percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secretaries</td>
<td>5</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Heads of Departments (HOD)</td>
<td>5</td>
<td>4</td>
<td>80</td>
</tr>
<tr>
<td>Bursars</td>
<td>3</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>Buyers</td>
<td>3</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>Stores clerks</td>
<td>2</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>ICT staff members</td>
<td>3</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>Suppliers</td>
<td>5</td>
<td>4</td>
<td>80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Target groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secretaries</td>
</tr>
<tr>
<td>Count</td>
</tr>
<tr>
<td>Challenges</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Table 4. 1 : Questionnaire sent-responses received ratio

4.4 Questionnaire analysis
This section is focusing on the analysis and presentation of the questions and responses from the questionnaires returned by all the seven (7) target groups:

4.5 System usability
4.5.1 Did you face any difficulties using the web based e-procurement system?
This question was responded to by secretaries and buyers to check if they faced any challenges interacting with the system or not. The results are shown in the table below:

Table 4. 2 Challenges faced by user whilst using the system
The figure below shows the graphical representation of user response in the table above.

![Graphical representation of user response](image)

**Figure 4.1: Challenges faced**

The results show that majority of the secretaries and buyers responded that they did not face any changes using the system. Four (4) secretaries making 80% and two (2) buyers making 66.7% rated that they did not face any challenges. Only 20% for secretaries and 33.3% of buyers faced some challenges.

**4.5.2 Is the system easy to navigate?**

This question was responded to by the secretaries, HODs, buyers, bursars, stores clerks, administrators and suppliers checking whether the system features were easy to navigate (user friendly) or not. The results are shown in the table below:

<table>
<thead>
<tr>
<th>Work simplification</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secretaries</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>HODs</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bursars</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Buyers</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Store clerk</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Administrator</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Supplier</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Table 4.3 System easy to navigate**
The figure below shows graphical illustration of user response in Table 4.3 on how easy the system is to navigate.

![Figure 4.2: Easy system navigation](image)

Only a small percentage of 25% of suppliers, 20% for both secretaries and HODs responded with a ‘neutral’ answer. As shown by the clustered graph majority of the sample from different strata was totally (strongly) agreeing and agree that the system was easy to navigate.

### 4.5.3 The web based e-procurement system help to simplify and complete my work?

The question stated above was responded to secretaries, HODs, bursars, buyers and stores clerks only if the system simplifies or improves the process of how work is being handled.

<table>
<thead>
<tr>
<th>Work simplification</th>
<th>Target groups</th>
<th>Target groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Secretaries</td>
<td>HODs</td>
</tr>
<tr>
<td></td>
<td>Count</td>
<td>N %</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>3</td>
<td>60.0%</td>
</tr>
<tr>
<td>Agree</td>
<td>1</td>
<td>20.0%</td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>20.0%</td>
</tr>
<tr>
<td>Disagree</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>0</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

*Table 4.4 Simplification of work*
The graphical representation of the results in table 4.4 is shown in the figure below.

![Figure 4.3: Work simplification](image)

Only 1 secretary making 20% and 1 HOD making 20% were neither agreeing nor disagreeing about the system’s ability to simplify work. As shown on the clustered bar graph most people from different strata were in full support of the web based e-procurement system in helping to simplify their respective tasks.

4.6 System functionality

4.6.1 Does the system provide for raising of purchase requisitions and electronic tracking?

Secretaries responded to the above question expressing how good or best is the system in generating or handling requisitions and well as tracking them. The results are shown in the table below:

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>3</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>3</td>
<td>60.0</td>
<td>60.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Agree</td>
<td>1</td>
<td>20.0</td>
<td>20.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>20.0</td>
<td>20.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 4.5: Purchase requisition processing by the system*
The figure below shows the graphical representation of the response to Table 4.5 on issues of requisition processing.

Figure 4.4: Purchase requisition processing

The results show that majority of the secretaries strongly agreed and agreed that the system was good in processing purchase requisitions. 3 secretaries constituting 60% was in strong support, 1 secretary constituting 20% was in support whereas the last 1 constituting another 20% was neutral on requisition processing by the web based e-procurement system.

4.6.2 Is a workflow system utilized to streamline the authorization process and provides e-tracking of purchase orders and requisition?

The above question was responded to by the HODs, it focuses on whether the system has provision to authorize and track purchase requisitions as well as purchase orders.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>1</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Agree</td>
<td>3</td>
<td>60.0</td>
<td>60.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>20.0</td>
<td>20.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6 Workflow usable in streamlining authorization process
The figure below illustrates the results in table 4.5 on the issue of workflow being used in authorization process of purchase requisitions and purchase orders.

1 HOD constituting 20% strongly support and 3 HODs constituting 60% agreed that the workflow part was helpful in making authorizations. Only 1 HOD constituting 20% was neutral.

4.6.3 Does the system allow buyer-supplier interaction, choosing best supplier, provision of sms alerts, and electronic transmission of purchase documents and generation of reports?

This question was responded to by the buyer expressing how the web based e-procurement system improved the procurement processing as most of the functions they perform was being performed by the system.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>2</td>
<td>66.7</td>
<td>66.7</td>
<td>66.7</td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>33.3</td>
<td>33.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 4. 7 Procurement process improvement*
The results of table 4.7 are displayed on the figure or graphical representation below.

![Figure 4.6: Procurement process improvement](image)

According to the table or graph shown above, 2 buyers constituting 66.7% of buyers were in full support of the web based e-procurement system as a way that improves procurement process except for only 1 buyer constituting 20% was neutral.

4.6.4 Does the system provide for the payment and generation of payment advice?

The above question was responded to by the bursar, to check whether the system had provision of payment and send proofs.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Valid</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>2</td>
<td>66.7</td>
<td>66.7</td>
<td>66.7</td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>33.3</td>
<td>33.3</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 4.8 Payment processing*
The figure below shows the results of table 4.8.

![Figure 4.7: Payment processing](image)

The results above show that 2 bursars constituting 66.7% were in full support or strongly agree that the system had provision of better payment mechanisms whereas 1 bursar constituting 33.3% was neutral.

**4.6.5 Does the system allow authorization and procurement documents matching?**

The above question was responded to by the stores clerk.

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>1</td>
<td>50.0</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Agree</td>
<td>1</td>
<td>50.0</td>
<td>50.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 4. 9 Improved delivery processing.*
The results of the above table 4.9 were graphically represented in the figure below.

**Figure 4.8: Improved delivery processing**

The results show that all members of the stores clerk were agreeing that the web based e-procurement system has an improved delivery processing mechanism.

**4.6.6 Does the system provide suppliers with quick notifications and allow them to complete intended jobs?**

The above question was responded to by the suppliers, indicating whether they were able to receive notifications and as well had access to the system to perform intended work.

<table>
<thead>
<tr>
<th>Supplier system functions support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Valid</td>
</tr>
<tr>
<td>Strongly agree</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

*Table 4.10 Supplier system functions support*
The results of the table 4.10 above are shown by the graphical representation or figure below.

Figure 4.9: Supplier system functions support

The results above show that, 2 suppliers constituting 50% strongly agreed and 1 supplier agreed that the web based e-procurement system provided the supplier with necessary functions to be able to collaborate with internal stakeholders whilst only 1 supplier constituting 25% disagreed on the above.
4.7 System performance

4.7.1 Is the system accurate in terms of information quality, system usefulness and usage?

The question above was focused on finding out more about system accuracy, it was responded to by secretaries, HODs, bursars, buyers, stores clerks and administrators.

<table>
<thead>
<tr>
<th>Target groups</th>
<th>Count</th>
<th>Column N %</th>
<th>Count</th>
<th>Column N %</th>
<th>Count</th>
<th>Column N %</th>
<th>Count</th>
<th>Column N %</th>
<th>Count</th>
<th>Column N %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System accuracy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly agree</td>
<td>3</td>
<td>60.0%</td>
<td>1</td>
<td>20.0%</td>
<td>2</td>
<td>66.7%</td>
<td>1</td>
<td>33.3%</td>
<td>1</td>
<td>50.0%</td>
</tr>
<tr>
<td>Agree</td>
<td>1</td>
<td>20.0%</td>
<td>3</td>
<td>60.0%</td>
<td>0</td>
<td>0.0%</td>
<td>1</td>
<td>33.3%</td>
<td>1</td>
<td>50.0%</td>
</tr>
<tr>
<td>Neutral</td>
<td>1</td>
<td>20.0%</td>
<td>1</td>
<td>20.0%</td>
<td>1</td>
<td>33.3%</td>
<td>1</td>
<td>33.3%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Disagree</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Table 4.11 System accuracy

The results in table 4.10 above are represented on a clustered bar graph below.

![Figure 4.10: System accuracy](image)

The results shown that 20% of secretaries, 20% of HODs, 33.3% of bursars and 33.3% of buyers responded to be neutral on the issue of system accuracy. In contrast to the remaining percentages, which are significantly large and fall into categories of those whose strongly agree and those who agree. Clearly it can be seen that most people agree that the system is accurate considering number on the graph.
4.7.2 How do you rate the web based procurement system in terms of performance?

The above question was centered on finding out more on ratings in terms of system performance. The results from various groups of strata are shown in the able and figure below.

<table>
<thead>
<tr>
<th>System performance</th>
<th>Secretaries</th>
<th>HODs</th>
<th>Bursars</th>
<th>Buyers</th>
<th>Store clerk</th>
<th>Administrators</th>
<th>Suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count N %</td>
<td>Count N %</td>
<td>Count N %</td>
<td>Count N %</td>
<td>Count N %</td>
<td>Count N %</td>
<td>Count N %</td>
<td>Count N %</td>
</tr>
<tr>
<td>Excellent</td>
<td>2 40.0%</td>
<td>1 20.0%</td>
<td>2 66.7%</td>
<td>2 66.7%</td>
<td>1 50.0%</td>
<td>1 33.3%</td>
<td>2 50.0%</td>
</tr>
<tr>
<td>Good</td>
<td>1 20.0%</td>
<td>2 40.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>1 50.0%</td>
<td>2 66.7%</td>
<td>1 25.0%</td>
</tr>
<tr>
<td>Neutral</td>
<td>1 20.0%</td>
<td>1 20.0%</td>
<td>1 33.3%</td>
<td>1 33.3%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>1 25.0%</td>
</tr>
<tr>
<td>Poor</td>
<td>1 20.0%</td>
<td>1 20.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
</tr>
<tr>
<td>Bad</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
</tr>
</tbody>
</table>

Table 4.12 System performance rating

The results of the table 4.11 above are represented on a clustered bar chart below.

Figure 4.11: System performance ratings

The graph and tabulated results shows that 20% secretaries, 20% HODs, 33.3% bursars, 33.3% buyers and 25% suppliers responded with a neutral decision. 20% Secretaries and 20% HODs reflected that the system performance was poor. However, large percentages of the seven groups was in strong support that the system performance was good, this is reflected by the responses of excellent and good.
4.7.3 Using the web based e-procurement system saves time?

The question above was focused on finding out from the different groups if the system is time effective and the results of the responses were given in the table and figure below.

<table>
<thead>
<tr>
<th>Time effectiveness</th>
<th>Target groups</th>
<th>Count</th>
<th>N %</th>
<th>Count</th>
<th>N %</th>
<th>Count</th>
<th>N %</th>
<th>Count</th>
<th>N %</th>
<th>Count</th>
<th>N %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td>Secretaries</td>
<td>3</td>
<td>60.0%</td>
<td>2</td>
<td>40.0%</td>
<td>1</td>
<td>33.3%</td>
<td>1</td>
<td>33.3%</td>
<td>1</td>
<td>50.0%</td>
</tr>
<tr>
<td>Agree</td>
<td>HODs</td>
<td>2</td>
<td>40.0%</td>
<td>2</td>
<td>40.0%</td>
<td>2</td>
<td>66.7%</td>
<td>1</td>
<td>33.3%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Neutral</td>
<td>Bursars</td>
<td>0</td>
<td>0.0%</td>
<td>1</td>
<td>20.0%</td>
<td>0</td>
<td>0.0%</td>
<td>1</td>
<td>33.3%</td>
<td>1</td>
<td>50.0%</td>
</tr>
<tr>
<td>Disagree</td>
<td>Buyers</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>Store clerk</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Suppliers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.13 Time effectiveness

The results in table 4.12 are shown or represented in the figure below.

Figure 4.12: Time effectiveness

The results show that, a small percentage from various groups such as 20% HODs, 33.3% buyers, 25% suppliers and a significant rise of up to 50% store clerks reflected that they are neutral as far
as time effectiveness in concerned. However, larger significant percentages of these different
groups shows that they agree that the web based e-procurement system is time effectiveness.

4.8 Time comparison of executing tasks in traditional method and web based method

The table below shows average time the web based e-procurement system takes to execute to
completion tasks in the table as compared to the manual procurement system. The time of the web
based system was done using system profiling which records all the activities performed on the
system in terms of time. After testing with five departments the average time was calculated and
tabulated.

<table>
<thead>
<tr>
<th>Task</th>
<th>Average time of departments when using traditional procurement method (minutes)</th>
<th>Average time of departments when using web based e-procurement system (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create and posting purchase requisition</td>
<td>6</td>
<td>2.8</td>
</tr>
<tr>
<td>Approval of purchase requisition</td>
<td>5</td>
<td>0.064</td>
</tr>
<tr>
<td>Notifying suppliers asking for quotations</td>
<td>6</td>
<td>0.03</td>
</tr>
<tr>
<td>Generating comparative bid analysis document for supplier evaluation</td>
<td>23</td>
<td>0.89</td>
</tr>
<tr>
<td>Creating and sending quotations</td>
<td>12</td>
<td>0.56</td>
</tr>
<tr>
<td>Generating purchase orders</td>
<td>15</td>
<td>0.034</td>
</tr>
<tr>
<td>Secretary notification on delivery.</td>
<td>2</td>
<td>0.032</td>
</tr>
<tr>
<td>Report generation by buyer</td>
<td>11.5</td>
<td>0.64</td>
</tr>
<tr>
<td>Purchase requisition tracking</td>
<td>4.5</td>
<td>0.07</td>
</tr>
<tr>
<td>Total average time</td>
<td>9.4</td>
<td></td>
</tr>
</tbody>
</table>

*Table 4. 14 time to execute web based procurement vs traditional procurement system*
The results of the table above are shown in the figure below.

4.9 CPU and Memory Usage of Web based e-procurement system

The table below shows average CPU usage in percentage, memory (Megabytes) and disk space (Megabytes) of the web based procurement system executing any task of the system on it and after using the system.

<table>
<thead>
<tr>
<th>Application</th>
<th>CPU usage %</th>
<th>Memory (Megabytes)</th>
<th>Disk (Megabytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google chrome after launching the web based e-procurement system</td>
<td>2.33375</td>
<td>54.575</td>
<td>0.1</td>
</tr>
<tr>
<td>Google chrome before launching the web based e-procurement system</td>
<td>1.45</td>
<td>50.7</td>
<td>0.0</td>
</tr>
</tbody>
</table>

4.10 Discussion of results

The researcher observed that the use of the web based e-procurement system resulted in less time to complete procurement process as compared to the traditional procurement system. This is supported by the following:

On system usability, respondents from the different strata showed that the system was usable. Majority of the buyers and secretary’s responses showed that they did not face any challenges
using the system, because it was easy to navigate their respective system functionalities. A few challenges faced was on lack of experience to use the system. A greater percentage was in full support that the system simplifies their respective duties as it allowed them to complete their respective task.

On system functionality, a larger percentage strongly agreed and some agreed that the system was functional. This was after the respond to different questions pertaining to their respective functions. I observed that a large number from the seven-group sample was in full support that the web based e-procurement system performed the intended functions. For those who responded with a neutral or poor answer, the reasons were that they had other functionalities that they wanted to be on the system of which is part of future work.

On system performance, despite majority users from different groups rated the system excellent and poor, the researcher went on to calculate the average CPU usage, disk usage, memory usage and average completion time to execute some tasks in procurement comparing them with the traditional system. As shown in the table, the web based e-procurement system uses small amount of memory of about 54.575 MB (Megabytes), 2.3375 % of CPU and disk space of 0.1MB (Megabytes). A test of the web based e-procurement system was done on different machines and a relatively small difference of the CPU usage, disk usage and memory usage was obtained. Hence, the researcher concluded that this system consumes normal memory just like other web application systems.

The researcher observed that using a web based e-procurement system reduces time it takes for the university to complete procurement s compared to the manual way of procuring.

4.11 Chapter summary

The results obtained by the researcher reflects that the web based e-procurement system help to reduce the time it takes to acquire goods and services. The system enable secretaries form different departments to create, alter, edit and track purchase requisitions, which solves the issue of geographical isolation of campuses. In addition, the system is able to solicit and make comparative analysis of suppliers choosing the best and eliminate biasness problem. Lastly, use of sms notifications help to reduce the time of procurement as suppliers are made aware of the contracts they will have been awarded.
Chapter 5: Conclusions and Recommendations

5.1 Introduction
This chapter is the epilogue of the project. It gives a comprehensive and summarized finding, from which conclusions shall be drawn. Having done much of the work during the study which was governed by a set of objectives, the researcher managed to meet all three objectives as alluded to in the introductory chapter. The overall analysis of the web based e-procurement system will give insight to interested parties on areas that may need further attentions and expectations. Lastly, future work for the study is also recommended in this chapter.

5.2 Major conclusions drawn
The aim of this project was to design and develop a web based e-procurement system to be used by Bindura University of Science Education (BUSE) departments for acquiring goods and services. The researcher had to come up with the system, successfully managed to achieve objectives and most of the research questions were answered.

The implementation of the web-based e-procurement system at BUSE has proven to be a viable solution in reducing the time taken for acquiring of goods and services. It is useful as it tackles the problems of the current manual procurement method through its system functionalities.

5.3 Recommendations
Although major work of this research was covered and set objectives were met, the researcher would like to go an extra mile highlighting certain areas that could be expanded on research in future.

Firstly, there is need expand the system and make complete it complete by adding more departments and users. The study was done using a few test users and departments for the purposes of cutting project scope.

Also there is need to add more modules such as the stock management system using e-requisition system to be used by departments requesting goods for the stores. Furthermore, the stores can use the same system to manage stores and trigger the suppliers when re-order level is met.

In addition, another area to be considered as future work is about e-tendering (advertising and e-sharing of tenders from suppliers), integrating with a proper payment gateway and platform to allow for e-budgeting.
Reference


29. ‘Public procurement and disposal of public assets act [chapter 22:23) arrangement of sections


Appendix A

Assessment Questionnaire

My name is Tapiwa L Kombe and I am a computer science undergraduate student doing the final year at Bindura University of Science Education (BUSE). It is part of the university’s requirements that all students carry out a research project in partial fulfilment of the degree requirements. I am doing a research on the improving the procurement process of the university by developing a web based e-procurement system. Therefore, I am kindly asking for your faithful contribution, as your responses will help in coming up with the results for this study. Information provided will be used exclusively for the purpose of academic research only.

You can respond to the question by ticking one box of your choice or by giving a brief opinion.

Section A: System Usability

Part 1 NB: This question is applicable to Secretaries and Buyers only.

1. Did you face any difficulties using the web-based e-procurement system?
   Yes [ ] No [ ]

Part 2 NB: This question is applicable to Secretaries, HODs, Buyers, Bursars, stores clerk, administrators and suppliers only.

2. Is the system easy to navigate?
   Strongly agree [ ] Agree [ ] Disagree [ ] Neutral [ ]

Part 3 NB: This question is applicable to Secretaries, HODs, Buyers, Bursars and stores clerks only.

3. The web-based e-procurement system help to simplify and complete my work?
   Strongly agree [ ] Agree [ ] Disagree [ ] Neutral [ ]

Section B: System Functionality

Part 3 NB: This question is applicable to Secretaries only.

4. Does the system provide for electronic tracking of order and purchase requisition?
   Strongly agree [ ] Agree [ ] Disagree [ ] Neutral [ ]

5. Is a workflow system utilized to streamline the authorization process?
   Strongly agree [ ] Agree [ ] Disagree [ ] Neutral [ ]

Part 4 NB: This question is applicable to HODs
6. Does the system provide for raising of purchase requisitions and electronic tracking?
   Strongly agree □ Agree □ Disagree □ Neutral □
   Part 5 NB: This question is applicable to Buyers only.

7. Does the system allow buyer-suppliers interaction, choosing best supplier, provision of
   sms alerts, electronic transmission of purchase documents and generation of reports?
   Strongly agree □ Agree □ Disagree □ Neutral □
   Part 6 NB: This question is applicable to Bursars only.

8. Does the system provide for the payment and generation of payment advice or notice?
   Strongly agree □ Agree □ Disagree □ Neutral □
   Part 7 NB: This question is applicable to Stores clerks only.

9. Does the system allow authorization and procurement documents matching?
   Strongly agree □ Agree □ Disagree □ Neutral □
   Part 8 NB: This question is applicable to Suppliers only.

10. Do you receive sms notifications supplier as well as access to the system to respond to
    RFQ?
    Strongly agree □ Agree □ Disagree □ Neutral □
    Section C: System Performance
    Part 9 NB: This question is applicable to Secretaries, HODs, Buyers, Bursars, stores clerk,
    and administrators only.

11. Is the system accurate in terms of information quality, system usefulness and usage?
    Strongly agree □ Agree □ Disagree □ Neutral □
    Part 10 NB: This question is applicable to Secretaries, HODs, Buyers, Bursars, stores clerk,
    administrators and suppliers only.

12. How do you rate the web based procurement system in terms of performance?
    Excellent □ Good □ Neutral □ Poor □ Good □
    Part 11 NB: This question is applicable to Secretaries, HODs, Buyers, Bursars, stores clerk
    and suppliers only.

13. Using the web-based e-procurement system saves time?
    Yes □ No □
Part 12 NB: This question is applicable to every user.

14. What do you think about replacing the current manual procurement method with the web-based e-procurement system?

____________________________________________________________________________________________________________________________________

____________________________________________________________________________________________________________________________________

Thank you so much for your support. May you kindly fill in the following details for reference purpose.

Name(s): ................................................................................................................

Address: ................................................................. Occupation: .........................

Phone number: ................................................................. Signature: ........................


Appendix B

**Interview Questions Guide**

1. Which system is being used by the University for Procurement?
2. What are the problems with the current procurement system?
3. Does the current procurement system allow easy interaction of users from different departments and/or levels, as well with external clients like suppliers?
4. How much time does it take for the following processes to be completed using the current manual procurement method than the web-based e-procurement?

<table>
<thead>
<tr>
<th>TASK</th>
<th>Average time of departments using traditional procurement method (minutes)</th>
<th>Average time of departments using traditional procurement method (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create and posting purchase requisitions requisition</td>
<td></td>
<td></td>
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<tr>
<td>Approval of purchase requisition</td>
<td></td>
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<tr>
<td>Notifying suppliers asking for quotations</td>
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<tr>
<td>Generating comparative bid analysis document for supplier evaluation</td>
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<tr>
<td>Creating and sending quotations</td>
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<tr>
<td>Generating purchase orders</td>
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<tr>
<td>Secretary notification on delivery.</td>
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<tr>
<td>Report generation by buyer</td>
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<td></td>
</tr>
<tr>
<td>Purchase requisition tracking</td>
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<td></td>
</tr>
</tbody>
</table>