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Building Blocks for a Model for using EDI and ERP to Improve Supply Chain Performance in Ugandan PDEs

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Abstract: The study's overarching goal is to provide a theoretical foundation for the integration of EDI and ERP systems into Ugandan procurement and disposal entities' supply chains to optimize their performance. A design science approach was used as a research strategy and for data collection; a cross-sectional survey using qualitative techniques, including in-depth interviews was employed. From the findings, a model was developed for data visualization, report production, analytics, and transformation. This study therefore provides an in-depth evaluation of the effectiveness of procurement and disposal organizations in Uganda with the help of EDI and ERP technologies to enhance supply chain management.

Keywords: *Electronic Data Interchange, Enterprise Resource Planning, Supply Chain Performance.*

1. Introduction

The supply chain includes all entities engaged in the transfer of goods, services, funds, and information from, the point of origin to the customer identification process, or CIP (Smith, Yost, and Lopez, 2020). The process is made up of linked nodes that allow a commodity to be transported from the supplier to the receiver (Fichman, 2011). IT and EC play critical roles in supply chains in a variety of businesses. To achieve a competitive advantage in the changing global economy, a rising number of firms in developing countries are incorporating Information and Communication Technologies (ICTs) into their supply chain operations (Gupta, 2014). According to prevalent scholarly opinion, information and communication technology (ICT) delivers significant advantages through promoting integration inside enterprises and across supply chains. This is performed by enhancing information flow between commercial partners, discovering prospective suppliers, and lowering administrative costs. These advantages improve an organization's openness and accountability [Huemer, Liegl, and Zapletal, 2020; Katuu, 2020). Several technologies have the potential to enhance supply chain performance. This list includes, among other things, Electronic Data Interchange or EDI, electronic point of sale, enterprise resource planning, or ERP, bar code scanners, online services, electronic buying, electronic sourcing, and electronic auctioning (Klapita, 2021; Sheikh Younis, 2019; Abro, Memon, Shah and Naqvi, 2017).

This study examines the use of EDI and ERP technologies to enhance supply chain performance in Uganda's purchasing and disposing entities (PDEs). These systems provide a thorough grasp of operational efficiency. Publicly disposable entities are essential for facilitating the acquisition and disposal of assets in government organizations. Government entities follow a bureaucratic procedure when providing assets and services. This procedure includes stages such as soliciting bids, selecting the bidder with the highest bid, and exchanging and signing procurement documents in compliance with legal requirements (Almigheerbi and Lamek, 2020). This process leads to delays, which in turn leads to higher expenses for resources and labor, additional expenses for administration, reduced user satisfaction, higher capital investment, and increased storage costs (BC, 2020). Developed nations have effectively utilized Electronic Data Interchange or EDI and Enterprise Resource Planning systems in supply chain management. Developing countries have encountered difficulties in adopting EDI and Enterprise ERP systems due to their high costs and complexity. This has been especially challenging for small and medium enterprises (SMEs), as implementing these systems requires significant investments (Hueme, Liegl, & Zapletal, 2020).

Currently, there have been advancements in technology that have made Electronic Data Interchange or EDI and Enterprise Resource Planning or ERP systems more affordable and easier to implement. These applications can function on both mainframe and microcomputer platforms, leading to cost reduction (Kiggira, Mwirigi, & Shale, 2015). In Africa, countries like South Africa and Egypt, which have middle-income status, have experienced significant growth in technology adoption. The utilization of EDI and ERP systems has significantly increased among small and medium-sized enterprises (SMEs) (Kim, et al., 2019). Uganda has

witnessed a noticeable rise in the utilization of technology, specifically in the adoption of Electronic Data Interchange (EDI) and Enterprise Resource Planning (ERP) systems in supply chain management, during the past decade. However, the continued manual processing of procurement documents leads to increased delays in the procurement process (Liban, et al., 2023; Makotose, 2019). Based on the factors discussed above, the researcher proposes a conceptual framework that recommends the use of EDI and ERP systems to improve supply chain management by digitizing procurement document processing.

2. Background Literature and Hypothesis Development

Using the framework of resource dependence theory (Hillman, Withers, and Collins, 2009). This study seeks to investigate the connection between Electronic Data Interchange (EDI), Enterprise Resource Planning (ERP) and supply chain performance among Uganda's Public Development Enterprises (PDEs). The resource dependency hypothesis (Hillman, Withers, and Collins, 2009).] Postulates that the acquisition and management of resources are critical for supply chain success. Wernerfelt (1975) argues that a company's resources may be thought of in terms of its strengths and weaknesses. According to this hypothesis, ERP and EDI are useful tools that influence the efficiency of businesses, which in turn improves the effectiveness of supply chains. Enterprise resource planning (ERP) is seen as an external resource in this approach, used to improve supply chain operational efficiency. Due to the link between the supply chain and the resources needed for peak performance (Smith, Yost and Lopez, 2020), the use of ERP or Enterprise Resource Planning and EDI or Electronic Data Interchange is recommended so long as these technologies are shown to be useful. According to RDT or Resource Dependency Theory (Hillman, Withers, and Collins, 2009), supply chain performance is the degree to which an organization's supply network satisfies the requirements of its customers. Stakeholders are the many individuals and organizations that have an interest in the success of the supply chain (Eyaa, Ntayi and Namagembe, 2010). Supply chain effectiveness is largely determined by how well operations inside the chain are evaluated from the outside. Supply chain performance evaluation requires an external viewpoint, whereas internal viewpoints are primarily concerned with measuring the efficiency of internal processes (Choudhary and Jadoun, 2016).

Electronic Data Interchange and Supply Chain Performance: To enhance the performance of an organization, it is imperative that every component of its supply chain, including departments, activities, individuals, hierarchical levels, and external stakeholders, effectively collaborate. This is a result of people and activities being interdependent, where each entity influences the others (Grant, & Tu, 2013). Relationships between supply chain participants, such as bit suppliers and end users, are essential to the chain's smooth operation. The coordination of production and logistics is a defining feature of these partnerships. This form of coordination necessitates the integration of supply chains, indicating that decisions regarding production, inventory, and delivery activities of both companies are made collectively (Gorbenko, et al., 2022). The utilization of Information Technology has the potential to enhance the coordination of supply chains, especially when these technologies are employed to transcend the conventional boundaries of firms involved in the supply chain. This particular category of information technology is commonly known as an inter-organizational information system, wherein electronic data interchange (EDI) serves as an illustrative instance of such a system.

The implementation of Electronic Data Interchange (EDI) has been observed to have a positive impact on inter-organizational coordination activities and the level of integration among supply chain members (Veselá, 2017). According to Choon et al. (2010), EDIs are characterized as the electronic exchange of standardized business transactions between computer systems. Conversely, Kaeferetal (2007) defines EDI as the electronic transfer of documents or information, specifically within a business-to-business context. Electronic data interchange (EDI) can be defined as the systematic exchange of structured data between different organizations through electronic channels. The process involves the automated transmission of electronic documents or business data between computer systems, specifically between trading partners, without the need for human involvement. Emails have evolved beyond simple communication tools, as organizations now utilize them for various purposes such as transmitting bills of lading and even checks through the appropriate Electronic Data Interchange (EDI) message (Klapita, 2022). The adoption of computer-based information systems by more businesses in the latter part of the 1960s led to the realization that a sizable portion of one

computer's output serves as input for another computer (Gu, and Huo, 2021). The integration of EDI into an organization's information technology system can be done in a seamless manner.

The classification of EDI can be categorized as either integrated or non-integrated. When one firm uses EDI just to exchange documents with another, this is known as non-integrated EDI (Huemer, Liegl, and Zapletal, 2020). Valaskova et al. (2022). In this case, the company is switching from a manual transfer mechanism, like the postal service, to a telecommunications approach while keeping all of its existing paper-based operations in place. Value-added network (VAN) providers are third-party companies that support the telecommunications transfer process. According to recent research, it has been estimated that more than 70% of organizations have adopted Electronic Data Interchange (EDI) (Veselá, 2017). To achieve successful implementation of EDI within an organization, several key factors must be considered. Firstly, the establishment of appropriate corporate policies is imperative. These policies serve as a framework to guide the proper implementation of EDI, ensuring consistency and adherence to organizational objectives. Additionally, it is essential to provide employees with comprehensive training on how to effectively utilize EDI systems. This training equips employees with the necessary skills and knowledge to navigate and leverage the capabilities of EDI. Lastly, fostering a culture of employee engagement and adaptability is crucial. This entails cultivating a mindset that embraces change and the integration of EDI into daily operations. By addressing these factors, organizations can enhance the likelihood of a successful EDI implementation (Almtiri and Miah, 2020).

Enterprise Resource Planning and Supply Chain Performance: To survive in today's competitive market, businesses must increase their velocity, quality, and adaptability while decreasing expenses. Under these circumstances, competition plays a pivotal role in driving organizational performance improvement. For these organizations to attain such performance, it is crucial to have access to precise and pertinent information both internally and externally and to effectively utilize this information (Katuu, 2020). To attain the intended objective, the utilization of information technology tools and information systems, such as Enterprise Resource Planning (ERP), along with the effective utilization of information technology, assumes a crucial role. These factors have a significant impact on acquiring and sustaining competitive advantages (Abro, 2017). Enterprise resource planning (ERP), as defined by Stevens (2003), is a catchall phrase for management software that incorporates a wide range of functionalities, including those related to production, finance, marketing, and human resources. Businesses may improve their product and service coordination with the help of these modules. The Enterprise Resource Planning system facilitates the management of external stakeholder relationships and improves performance management.

The system employs a centralized database and typically depends on a shared computing platform. The system offers the user a cohesive, coherent, and standardized environment. Enterprise Resource Planning (ERP) facilitates the dismantling of conventional organizational silos within companies and establishes a cohesive horizontal structure that aligns strategy, organizational structure, processes, and technology (AboAbdo, Aldhoiena, and Al-Amrib, 2019). In terms of the Information System, the adoption of an Enterprise Resource Planning (ERP) system is commonly the biggest project performed by the corporation (Klapita, 2021). This phenomenon is particularly prevalent in organizations located in developing countries, where a significant number of operational, control, and managerial systems remain non-automated. Moreover, these organizations do not exhibit the same level of reliance on entrenched legacy systems as their counterparts in developed countries. Rather than being used to replace older systems, several studies have shown that ERPs in developing nations are used to modernize and differentiate businesses (Kim et al., 2019). A recently implemented Information System has the potential to exhibit satisfactory performance, adhere to established timelines, and remain within budgetary constraints. However, there exists a possibility that it may subsequently face user rejection, leading to its eventual termination (Almigheerbi, Ramsey and Lamek 2020).

To mitigate the risk of user rejection and subsequent termination of a recently implemented Information System, the implementer must prioritize the processes of diffusion and infusion (Gorbenk, et al., 2022). In the realm of organizational innovation literature, diffusion is employed as a metric to gauge the internal dissemination of a particular innovation, indicating the degree to which its usage proliferates among individuals, projects, tasks, or organizational entities. This measure is particularly valuable, particularly in situations where implementation takes place in a phased manner. ERP adoption may be evaluated by

counting how many users there are throughout all departments and divisions, as well as how many components are used in each module (Gupta, 2014). Infusion refers to the assessment of the level of institutionalization and integration of a system within an organization's regular operations and essential procedures. Through the process of infusion, the system undergoes profound and comprehensive integration within the organization's work system and value chain. At this juncture, the organization would decide to enhance the integration of the system and expand its capabilities through the incorporation of additional modules or applications. This would help in launching new endeavors and forming alliances with other organizations (Abro, 2017). Transparency in complex business processes, relief from transactional and data limitations, and simplification of decision-making across the board would all result from the installation and integration of multiple systems inside the firm. As a result, the company's productivity as a whole would improve dramatically.

Review of Existing Models Used to Improve EDI and ERP Performance: For organizations to thrive in the contemporary dynamic landscape, they must enhance their speed, quality, flexibility, and cost efficiency. Consequently, competition becomes a crucial factor in driving organizational performance improvement. For these organizations to attain such levels of performance, it is crucial to have access to precise and pertinent information both internally and externally and to effectively utilize this information (Grant, & Tu, 2013). To accomplish this objective, the utilization of information technology tools and information systems, such as Enterprise Resource Planning (ERP), along with the effective utilization of information technology, assume a critical role. These factors have a significant impact on attaining and sustaining competitive advantages (Kim et al., 2019). According to Stevens (2003), enterprise resource planning (ERP) refers to a comprehensive suite of management software modules encompassing areas such as production, finance, marketing, and human resources. These modules enable companies to effectively strategize and coordinate their goods and services. The Enterprise Resource Planning (ERP) system facilitates the management of external stakeholder relationships and contributes to the improvement of performance management.

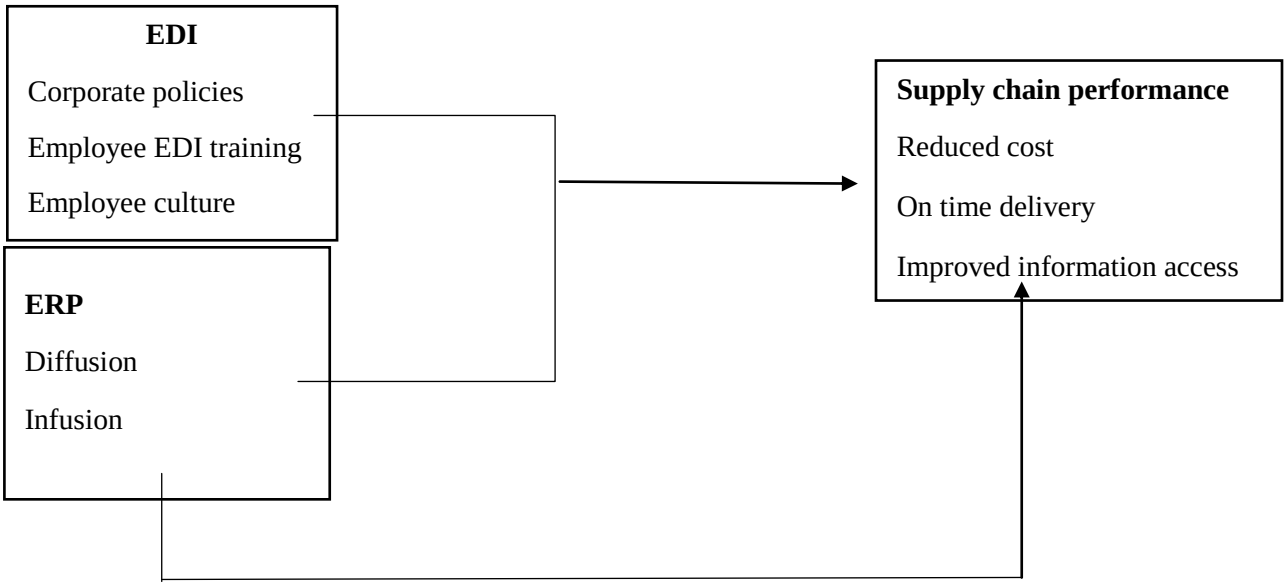
The system utilizes a centralized database and typically depends on a shared computing platform. The system offers the user a cohesive, coherent, and standardized environment. Enterprise Resource Planning (ERP) facilitates the dismantling of conventional organizational silos within companies and instead establishes a cohesive and interconnected horizontal structure. This structure ensures a strong alignment between strategy, organizational structure, process, and technology (Bulfone, 2023). In terms of the Information System, the adoption of an Enterprise Resource Planning (ERP) system is commonly the biggest project performed by the corporation (Chofreh, 2020). This phenomenon is particularly prevalent in organizations situated in developing countries, where a significant number of operational, control, and managerial systems still rely on manual processes. Moreover, these organizations do not exhibit the same level of reliance on entrenched legacy systems as their counterparts in developed countries. Rather than being used to replace older systems, several studies have shown that ERPs in developing nations are used to modernize and differentiate businesses (Sheikh Younis, 2019). A recently implemented Information System has the potential to exhibit satisfactory performance, adhere to established timelines, and remain within the allocated financial resources. However, there is the possibility of user rejection leading to the eventual termination of the system (Kim, et al., 2019).

To mitigate the risk of user rejection and subsequent termination of a recently implemented Information System, the implementer must prioritize the processes of diffusion and infusion (Smith, Yost and Lopez, 2020). In the literature on organizational innovation, diffusion is employed as a metric to assess the internal spread of usage among individuals, projects, tasks, or organizational units. This measure proves to be particularly beneficial in situations where implementation gradually takes place. The diffusion of ERP systems, or enterprise resource planning systems, is quantified by counting the number of departments and divisions that make use of them, as well as the number of users in each module (Kattu, 2020). Infusion refers to the evaluation of how thoroughly a system has been integrated into an organization's day-to-day activities and critical processes. Through the process of infusion, the system undergoes profound and extensive integration within the organization's work system and value chain. At this juncture, the organization would decide to enhance the integration of the system and broaden its capabilities through the incorporation of additional modules or applications. This would help in launching new endeavors and forming alliances with other organizations (AboAbdo, Aldhoiena, and Al-Amrib, 2019). The adoption of integrated and implemented

systems would increase transparency in complex business processes, as well as remove obstacles to information flow and decision-making. As a result, the company's productivity as a whole would see a major boost.

Conceptual Model: The theoretical framework that will inform this study will primarily draw upon the research conducted by Eyaa and Ntayi (2017). This study aims to examine the potential impact of Enterprise Resource Planning (ERP) and Electronic Data Interchange (EDI) on the supply chain performance of procuring and disposing entities in Uganda. The focus will be on evaluating the individual and combined effects of ERP and EDI on enhancing supply chain operations. The theoretical associations among the variables under investigation are depicted in Figure 1.

Figure 1: Conceptual Framework



Source: Modified from Hillman, Withers, and Collins, 2009; Barney, 1991; Kim et al., 2019; Chofreh, 2020).

3. Methodology

Research Approach: The chosen methodology employed in this study was the design science approach. Design Science refers to the systematic process of designing and studying artifacts within their respective contexts (Hevner and Chatterjee, 2010). The design science process consists of several key steps, which include problem awareness, solution suggestion, artifact development, evaluation, and conclusion.

Qualitative Study

Interviews: This entails a direct, in-person engagement between the researchers and the participants (Gray, et al., 2020). The researcher conducted interviews with multiple participants, and upon reaching the 22nd participant, no further new data emerged. Consequently, the researcher decided to conclude the process. The participants in this study were selected from a total of 10 probability density estimators (PDEs) using the sample determination method. These PDEs were chosen from three distinct categories of study participants. The researcher aimed to obtain comprehensive data by including a substantial number of respondents, allowing for the derivation of a valid conclusion. The categories of participants included in this study were as follows: Procurement officers are individuals responsible for managing the acquisition of goods and services on behalf of an organization. These individuals were deemed significant due to their active participation in evaluating products, services, and suppliers, as well as engaging in contract negotiations with their clientele.

Finance officers are individuals responsible for managing the financial activities and resources of an organization. These people are important because they have a hand in producing critical data that

demonstrates the company's financial health, such as revenue reports, management reports, and spending caps for procurement. Information and Communication Technology (ICT) officers collaborate with a chosen Public Development Entity (PDE). These individuals were deemed significant due to their engagement in the oversight and upkeep of EDI and ERP management systems. The individuals' involvement encompassed two distinct stages, specifically data collection and model testing and validation. During the interviews, the researcher asked open-ended questions to learn more about the participants' experiences with EDI and ERP, as well as their thoughts on the limitations of these two technologies in improving supply chain performance. The researcher prepared an interview guide to use as a reference point during the interviews.

Inclusion Criteria: Participants must meet the minimum age requirement of 18 years or older. Additionally, they must be employed in a position involving one of the designated PDEs. It is expected that participants possess a fundamental understanding of computer operations. Furthermore, participants must express a voluntary willingness to partake in the study and demonstrate availability and flexibility in scheduling to accommodate research needs.

Sampling Technique: Participants were selected using a purposive sample strategy, and 10 PDEs were selected using a simple random selection method for this investigation. Participants were sought out until a sufficient number of records were accumulated.
RQ1: How can supply chain management be improved in Ugandan PDEs via the use of EDI and ERP**.**
The research method used to answer this question was design science, which emphasizes making and testing a product to improve its practical performance [21]. This study strategy was chosen because it was thought to be the most suitable. A methodical process led to the discovery of the answer to this enigma.

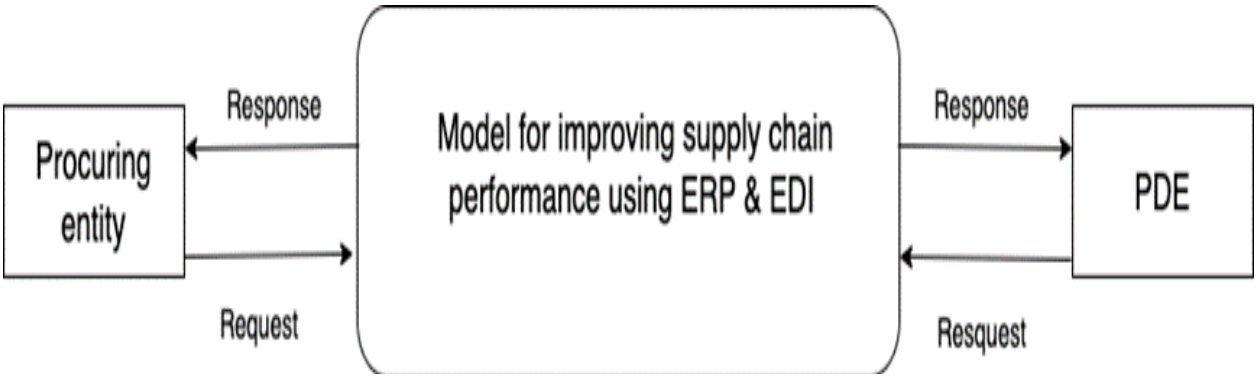
Awareness of the Problem: A meta-data search was used to analyze the pros and cons of current models and a gap in the literature was found as a result. Therefore, it was decided that a model proposing the integration of EDI and ERP would be the best strategy for improving supply chain performance. Respondent data led to requirement elicitation, which in turn inspired the creation of the suggested model.
RQ2: How can we optimize the architecture of an EDI/ERP model to boost supply chain efficiency in Ugandan PDEs?

Model Development: The solution to this puzzle was discovered through the use of model development strategies, such as the logical design of the prototype through the use of Unified Modeling Language (UML), Microsoft Workbench, and My Structured Query Language (MySQL). HTML, CSS3, JavaScript, and Hyper preprocessor (PHP) programming languages were used in the development of the EDI and ERP databases.

4. Results

The proposed framework recommends that Ugandan PDEs employ ERP and EDI systems, which consist of two modules: the procurement entity module and the supplier entity module, to boost supply chain performance.

Figure 2: Process Diagram



In this data flow diagram, the procurement entity and the PDE stand in for the business process model. Figure 3 depicts the diagram, which consists of four data stores and five operations.

Figure 3: Model Data Flow Diagram

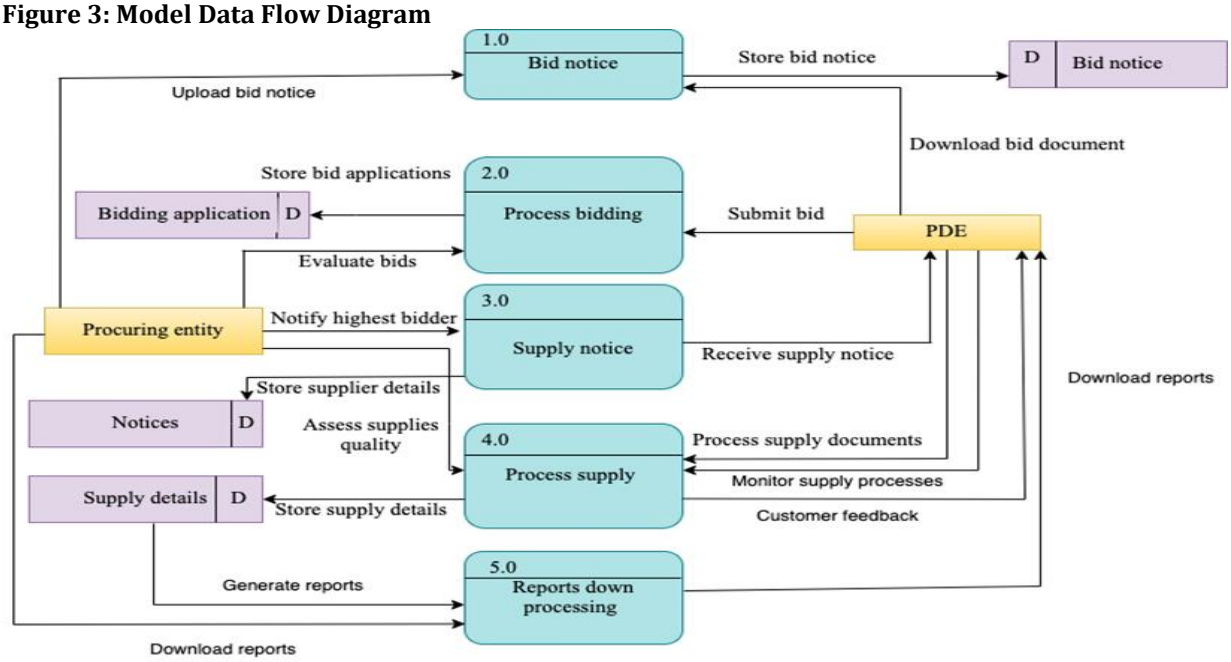
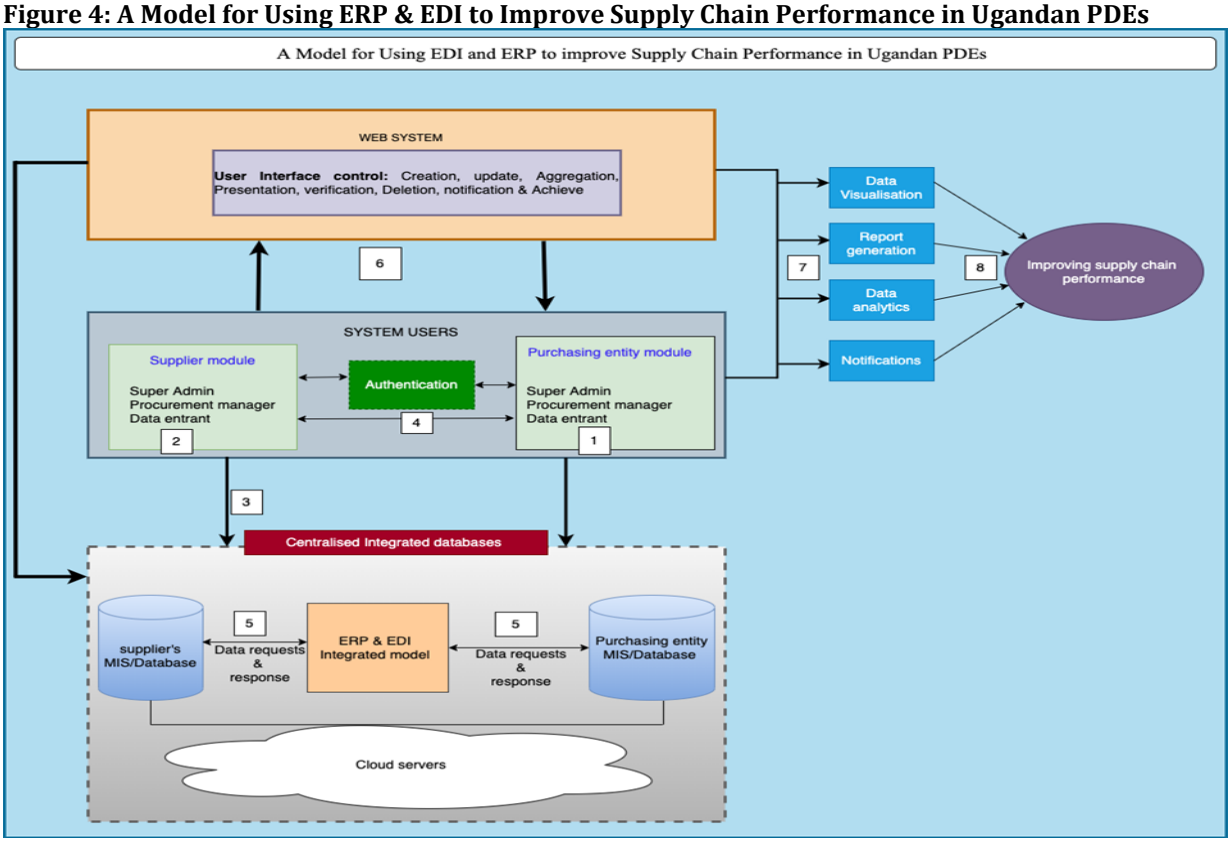


Figure 4: A Model for Using ERP & EDI to Improve Supply Chain Performance in Ugandan PDEs



Steps 1 and 2: The login procedure requires the user to provide their credentials, usually a username and password. Once the user provides these credentials, they undergo authentication to verify their identity, after

which they are granted access to the system. The system can be accessed through various devices, such as mobile phones, laptops, or desktop computers.
Step 3: the model's access to system resources is determined based on the parameters that have been triggered. It may either be granted or denied access.
Step 4: facilitates the exchange of files and data among entities.
Step 5: This stage facilitates a dynamic and engaging interaction among system users, Enterprise Resource Planning or ERP, and Electronic Data Interchange or EDI by executing various processes.
Step 6: Any user of the system has access to the functionality controls and the Data transformation controls, allowing them to change the way they see the data.
Steps 7 and 8: include automated processes such as data visualization, report generation, analytics, and transformation.

5. Discussion

This study offers a wide-ranging analysis of the supply chain's performance in Uganda right now. Further, a framework is put out to improve Uganda's supply chain by bringing together EDI and ERP software. This model is an attempt to fix the problems with current methods by making them more applicable to real-world problems. To help attain sustainable development objectives, the researcher uses a strategy that brings together academic research and real-world problems.

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