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TITLE: A FEASIBILITY STUDY FOR THE DEVELOPMENT OF AN AUTOMATED TENDER PROCESS "A CASE OF KWAZULU-NATAL (KZN) DEPARTMENT OF PUBLIC WORKS"

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ABSTRACT

The standard operation procedure provides an organized foundation for the organization's infrastructure supply and maintenance. This framework, which is broken down into phases, includes processes, methods, and procedures that are methodical, regulated, consistent, unified, and readily auditable. This study aims to investigate factors that militate against tendering processes, with the view of developing an automation system of tendering processes at the KwaZulu-Natal (KZN) Department of Public Works (DPW), South Africa (SA). The sample size consists of architects (50), quantity surveyors (50), contractors (100) and cconstruction managers (100) that were selected using the convenient sampling technique due to the small nature of the study. The data analysis was conducted using descriptive statistics. Findings of the study include the occurrence of corruption; and political and unethical practices as the factors causing poor tendering at KZN DPW. This results in time and cost increases. Based on these, the study developed an app to automate the processes of tendering at the processes at KZN DPW, SA. The study also finds that benefit accrues from automated tendering, which are reduction in corruption and affords transparency. The study recommends the adoption of the app developed for tendering practices the procurement of projects at KZN DPW, SA.

Keywords: Tendering; corruption; public works; projects

DECLARATION

This dissertation, except were indicated in the text, is the candidate's own work and has not been submitted in part, or in whole, at any other University or University of Technology.

This research was conducted at the Durban University of Technology under the supervision of Professor A. O. Aiyetan.

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DEDICATION

This dissertation is dedicated to my beloved wife, Mrs. N. Mhlongo, my mother Mrs. P. Z. Mhlongo and my boys Yandisa, Mawande and Kuyanda Mhlongo, my entire Mhlongo family especial my 24 biologically siblings, Also I cannot forget my RCCI Bishops and entire RCCI family (Restoration Christian Center International). Without your prayers and your support, I wouldn't have completed this work.

LIST OF ACRONYMS

KZN…….KWAZULU-NATAL

PPE…… PERSONAL PROTECTIVE EQUIPMENT

CIDB……CONTRACTORS INDUSTRY DEVELOPMENT BOARD

KZN DPW……...KWAZULU-NATAL DEPARTMENT OF PUBLIC WORKS

EPWP……. EXPANDED PUBLIC WORKS PROGRAMME

PAS……. PROGRAMME ADMINISTRATION SECTION

PM……...PROJECT MANAGER

PA……PRINCIPAL AGENT

BSC……. BID SPECIFICATION COMMITTEE

BEC……. BID EVALUATION COMMITTEE

BAC……. BID ADJUDICATION COMMITTEE

RM…… ..REGIONAL MANAGER

PBAD……. PRE-BID AND ADJUDICATION DIVISION

WIMS……. WORKS INFORMATION MANAGEMENT SYSTEM

ERP……. ENTERPRISE RESOURCE PLANNING

PFMA……. PUBLIC FINANCE MANAGEMENT ACT

MTEF……. MEDIUM-TERM EXPENDITURE FRAMEWORK.

H&S……. HEALTH AND SAFETY

BAM……. BID AVERAGE METHODS

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CHAPTER 1: THE PROBLEM AND ITS SETTING

1.1 INTRODUCTION

Tendering refers to the process of selecting a contractor to construct a (Edquist 1987; Edler et al. 2015; Hagedoorn, Link and Vonortas 2000 & Zabka, Pavela and Prokinova 2014). Tendering systems can be categorized as public tender or selective tender for the purposes of building, management, and collaboration. The characteristics of these systems, along with tender methods commonly used, are Edquist 1987; Edler et al. 2015; Hagedoorn, Link and Vonortas 2000 & Zabka, Pavela and Prokinova 2014. A construction project consists of complex processes involving stakeholders, long project durations and long contractual relations (Oyegeke and Dickson, 2020). Oyegeke and Dickson (2020) further mention that in recent years, the supply chain at the construction procurement stage has experienced a significant metamorphosis. This included everything from a revamped agenda for achieving more comprehensive policy goals connected to ecological responsibility to the lowest-cost, best-value procurement approach. However, tendering has not received enough attention in project management in KwaZulu-Natal (KZN) Public Works Departments (PWD) as the entire South African construction industry has been flooded by corruption (Oyegeke and Dickson, 2020).

According to Wasievw (2021), automation involves extracting values from current bid data related to work items and predicting the average for each based on past market rates and contract values. Tendering is a method for creating, managing, and fulfilling agreements amid parties. It can be defined as a sequence of logically connected steps carried out in a specific order, ultimately leading to the fulfilment of a significant output or the achievement of a key benchmark (International Organization for Standardization (IOS), (2018). Processes are supported by techniques, such as a recorded and methodically organized set of guidelines and procedures outlining the formal actions for executing a particular activity, which are influenced and moulded by an organization's policies (IOS, 2018).

The need for tendering should be the defining criteria for the process and should end when the transaction is completed. There are six principles of tendering which are as follows:

- Identify what needs to be procured.
- Select tendering tactics pertaining to the procurement process, cost and targeting approach, and agreement.
- Ask for tender deals.
- Assess tender deals.
- Award tender.
- Administrate the contract and confirm if all specifications are met.

Supply chain operational policies must be followed to implement the tendering principles. The current alternatives to tendering processes evolved out of the necessity to enhance the delivery of construction projects and ensure that they are completed on schedule and within the allocated funds (Babatunde, Opawole and Ujaddughe 2010). Babatude, Apowole and Ujaddughe (2010) mention that the emphasis on the tendering method is on maximizing time, money, and quality—the three main execution factors. The supply chain at the tendering stage of the project, working within these limitations, have all found it difficult to carry out their design duties, contracts and manage the investment.

Normally, construction projects begin when the client briefs the team on the designs he requires. Along with the professionals in engineering and the architect, a quantity surveyor provides advice on how design elements will affect costs (Babatunde, Opawole and Ujaddughe 2010). Thereafter, the contractor for the process of the production is selected. According to Kiromo (2015), some of the factors the firm takes into consideration include trust and commitment, adequate finance, quality, reliable delivery times, and adequate logistic and technological capabilities.

Kiage (2013) findings underscore that one of the leading failures in the public tendering process is inadequate administration and planning, which stem from needs that are not well identified, inaccurate cost estimations, unrealistic budgets and inadequate skills among procurement staff responsible for managing procurement. Kiage (2013) identifies the following setbacks in tendering process:

- Poor planning,
- Lack of competent staff,
- Poor quality control in the tendering process, and
- Delays in the tender awarding process.

In the private as well as government sectors, the achievement of the construction framework for reaching its stated goals depends on an effective oversight of the supply chain at the tendering function. (Kiromo 2015). There has been growing request by the public, other government service departments, and the construction industry for timely delivery of physical supplies and services by both public and private acquisition entities. This demand aims to intensify efficiency, strength, clarity and answerability by assorted user departments, which are captured in the World Bank procurement plan (Nzau and Njeru 2014).

The supply chain must maximize economic efficiency, encourage competition, and allow for impartial treatment of contenders during the tendering stage. It should maintain integrity in the promotion and fairness of operations, intensify clarity and accountability of processes, and increment the confidence of the service providers bidding for service delivery (Nzau and Njeru 2014). South African procurement departments have defaulted in the way they conduct their tendering process. It has been stated, for example, that a cartel controls the tendering process for the majority of personal protective equipment (PPE), limiting access to credible vendors. Currently, the supply chain departments in South Africa are at fault with a loss of R500 billion, which was allocated for COVID-19 relief. This loss is attributed to corruption in tendering and related scandals.

1.2 THE STATEMENT OF THE PROBLEM

A state economy's ability to function properly depends on the efficient completion of construction projects, which are mostly dependent on the supply chain during the tendering and procurement stages. The quality of life of residents and the country's development cycle are impacted when building delivery is restricted or unsatisfactory (Njeru and Nzau, 2014).

According to the World Bank's 2010 evaluation study, projects are only absorbing funding at a rate of under thirty percent. The low rate indicates that there is an association between the

accomplishment of the project with regard to fund usage and the tendering activity, and the procurement function cannot be entirely attributed to it (Nzau and Njeru 2014). Nzau and Njeru (2014) further mentions that the above statistic paints a dark picture about supply chain procurement role which has wholly fallen short of the demands of the construction industry, consequently tendering that does not achieve value for money for the stakeholders. The KZN Department of Public Works as it operates under national legislation however the tendering process has not been updated over the years as tendering of KZN Department of Public Works are still manual and it has been difficult to operate during COVID-19.

The Organization for Economic Co-operation and Developments (OECD) (2016) in its report states that one of the government processes that is most susceptible to corruption is public tendering. The intricacy of the bidding procedure, the intimate ties that exist between government employees and private enterprises, the participation of multiple parties, the significant number of transactions, and the substantial financial stakes all contribute to an increased risk of corruption.

Corruption Watch report of February 2013 state that Finance Minister Pravin Gordhan announced the appointment of a new Chief Procurement Officer as a measure to combat corruption. This new national procurement unit, operating under the National Treasury, is primarily focused on overhauling and streamlining the government's procurement procedures. Despite this effort, the tendering process remains prone to manipulation for personal advantage. Recent investigations by Corruption Watch have underscored how easily tender processes can be exploited.

A 2017 empirical study conducted by the Construction Industry Development Board (CIDB) highlighted major concerns about the ethical standards within South Africa's construction sector. The study revealed various ethical issues, such as deceit, deception, carelessness, conspiracy, bribery, and unjust behaviours. Contractors, along with other key stakeholders in the construction activity, were found to be heavily involved in these unethical behaviours. Notably, all architects (100%), most quantity surveyors (94%), a majority of consulting engineers (67%), and many contractors (60%) reported encountering professional negligence in the industry, including the use of substandard materials and poor craftsmanship, suggesting the hiring of unqualified parties.

1.3 MOTIVATION FOR AUTOMATION

According to Wasievw (2021), automation involves plotting and predicting the mean for every product depending on the historical market rate and contract value, using values from the current bid data against work components. These average values are intended to be plotted as standard rates and used as threshold levels for tendering in the future. The plan was to create these threshold values and observe whether the precision of predictions rises in tandem with a drop in the amount deviating from the contract. The system's creation proves that the threshold value plays a crucial role in reducing deviations among tenders, thereby enhancing the efficiency of procurement planning.

The implementation of an e-Tendering solution that utilizes the suggested approach and is integrated with the enterprise resource planning (ERP) system can result in significant benefits for the firm, including reduced costs and increased competitiveness. These improvements can be achieved through the provision of openness, equality, equal treatment, non-discrimination, workflow efficiency, performance, productivity, efficiency, effectiveness, and complete transparency.

According to Qusef, Daradkah, Sammour and Albadarnrh (2019), adopting the automated solution aligned with the proposed system and integrating it into the current framework can lead to substantial value additions and benefits for the enterprise, encompassing various facets such as cost savings, competitive edge augmentation, and operational efficiency.

Adedeji et al. (2017) stated that the introduction of automation systems in the construction tender process results in a quicker tendering activity, reduces the amount of paper used, makes transaction documentation simple, increases accountability, makes tendering documents easily accessible, increases process transparency, lowers the expenses of tendering, boosts competition among tenders, fosters imaginative thinking and innovation, and decreases corruption.

1.4 RESEARCH QUESTIONS

- What are the primary challenges affecting the efficiency and transparency of the tendering process at KZN DPW?
- How do competency and planning issues impact the outcomes of KZN DPW's tendering processes?
- What role do corruption and political constraints play in hindering effective tendering at KZN DPW?
- How could an automated tendering system address these challenges, and what potential benefits and risks would such a system bring?

1.5 THE AIMS AND OBJECTIVES OF THE STUDY

1.5.1 AIM

The study aim to examine challenges within the current tendering processes at KZN DPW and to develop an automated an automated tendering system that enhance efficiency, transparency, and accountability.

1.5.2 OBJECTIVES OF THIS STUDY

- To identify and analyse key challenges in the KZN DPW's tendering process, including planning inefficiencies, skill gaps, corruption, and political constraints.
- To assess how these challenges impact on cost, time, quality, and transparency in project delivery.
- To explore the potential benefits and risk of implementing an automated tendering system in reducing these challenges.
- To design and proposes an automated tendering model tailored to the KZN DPW that aligns with efficiency, transparency, and accountability goals.

1.6 THE HYPOTHESIS

Poor tendering planning, inexperienced staff, corruption, inadequate resource allocation, and poor budgeting delay the delivery of the project, confuse the processes, negatively impact the cost of the project and impact communication among stakeholders.

- Non efficiency and poor transparency of tendering process affect project delivery.
- Inexperienced tendering staff and poor planning issues negatively impact the tendering processes.
- Corruption and political constraints affect tendering process the KZN DPW.
- The benefits of an automated tendering system will improve tendering in the KZN DPW.

1.7 IMPORTANCE OF THE STUDY

Kiage (2013) conducted a study of factors affecting tendering performance in Kenya. The insufficiency of information regarding the bidding process, including its contributions, results, utilization of resources, and outcomes, poses a challenge for procurement departments of both public and commercial organizations, making it impossible to assess its efficacy and efficiency. Furthermore, such problems require the formation of distinct tendering and performance regulation. This study, aimed at enhancing the tendering process. Neglecting this study would perpetuate the existing issues within tendering, which have been notably detrimental to construction projects, as evidence during the COVID-19 pandemic.

Alhazmi and McCaffer (2000) conducted a study project on the tendering system selection model. They declared that selecting the correct tendering method could potentially decrease problems in construction projects by an average of 5%. It is further mentioned that each project is unique with its own characteristics and needs. For the project to be prosperous, the tendering know-how must act on the specialized characteristic of the task along with the client's and contractor's needs. It is now twenty years later, and it is very important to conduct this study to improve the tendering processes.

Babatunde, Opawole and Ujaddughe (2010) also conducted a study on the appraisal of project tendering methods in the Nigerian construction industry. The authors declare that the intention of every client at the outset of the project is to implement the plans successfully within the allotted time and budget; hence, the South African construction industry should adopt these

tendering methods. Ten years later, it is important to conduct the study as it will improve the tendering process. The disadvantage of not conducting this study is that it will have a negative impact on the supply chain management at the tendering stage as the systems will remain the same.

In their 2013 study, Rahim and Wan Daud explored the factors influencing the adoption of E-tendering systems. They emphasized the critical role of tendering as a significant and expensive business activity in project management, noting that projects often allocate a substantial portion, sometimes as much as 70% of their useable fund to procuring goods and services. The gap between the studies by Babatunde *et al*. (2010) and Rahim and Wan Daud (2013) is 12 years which makes this study important as it will improve the understanding of tendering.

Love and Li (2000) conducted a study on selecting a suitable tendering method for a building project, which states that when a building is completed on schedule, under budget, to the client's specifications, and with a high degree of satisfaction, the project can be considered successful. Nonetheless, a significant factor influencing this is the kind of tendering technique used. The authors go on to say that as an outcome, there is agreement on one bidding technique that is, for a given project, 'better' than all others, but that no one tendering technique is probably going to be superior to another for any project. The gap between the study by Love and Li (2000) and the present study is 20 years, underscoring the urgency of this investigation. Bridging this gap is crucial as it promises enhancements to tendering and procurement processes. Neglecting this study risks perpetuating the shortcomings in tendering practices.

Wanyonyi and Muturi (2015) studied factors affecting the performance function in public technical training institutions in Kenya which states that to achieve the goals of the tendering operation, all tenders, regardless of their monetary value, must adhere to the established procedure outlined in the Public Tendering and Disposal Act of 2007. The process needs to adhere to the established protocols in order to eliminate any chance of subpar performance. Every business project, no matter how big or small, relies on the transformation of input materials and/or services into outputs, both material and immaterial, which need to be arranged in a fruitful logistical framework to guarantee smooth and effective processes. It has been five years since Wanyonyi and Muturi (2015) conducted this study, and it is now time to improve the procurement and tendering processes. Neglecting to conduct this study will minimize the chances of progress.

Kiama *et al*. (2014) study on factors influencing the implementation of the public tendering act declared that tendering is a significant part of effective input administration and supply chain that is restrictive at all institutional levels. The availability of the appropriate material in appropriate quantities, at the appropriate times, for the appropriate purposes, at fair rates, and at distinguishable levels of quality is guaranteed by a successful tendering procedure. It has been six years since Kiama *et al* (2014). did this study and an improvement in the supply chain at the procurement stage; not reviewing the procurement after six years may mean no growth in the South African procurement systems.

Kioko and Were (2014) studied factors affecting the efficiency of procurement at public institutions states that the primary supplier of necessities including physical facilities, security, schooling, and health is the government. This is accomplished through the process of procurement, which makes it significant. The sheer amount of money involved in procurement has a significant effect on the economy and must be carefully controlled. Six years later it is necessary to improve the study on procurement and tendering processing.

The consequences of non-automated in tendering can affect project delivery, this can be factored by corruption, unethical practice, poor tender planning and political constrain. Tendering automation model is trusted that such model will be beneficial and contribute to cost saving, time saving and maximization quality. Time, cost, quality and safety satisfactions have been identified as the main criteria in measuring the overall success of the tendering process. Al-Moumani (2000), Dvir et al. (2003) and Faridi and El-Sayegh (2006) are some of the authors who maintain that; cost and time are the most important. They are the visible factors, considered critical because of the direct economic implications if they are not met.

1.8 THE DELIMITATION OF THE PROBLEMS

1.8.1 SAMPLING GROUPS

The study focuses on the development of an automation system for the tendering process at the KZN Department of Public Works. This study will include clients, general contractors, subcontractors, consultants, and all professionals who work directly with the KZN Department of Public Works. The general contractors will be drawn from the metropolitan area and must be listed in the CIDB database. The primary consultants, namely supply chain managers,

engineers, project managers, bid adjudicators and evaluators in the building construction industry, will constitute the consultant sample stratum. The client who initiates projects and the financiers will also be included in this study, as will the stakeholders in the construction industry.

1.8.2 Geographical Areas

The study area includes the head office of the KZN Department of Public Works and all regional and district offices in Thekwini, Ugu, Harry Gwala, Umgungundlovu, Uthukela, Umzinyathi, Zululand, Umkhanyakude, King Cetshwayo and the Ilembe District.

1.9 THEORETICAL FRAMEWORK

The systems theory, change management theory and ethics theories underpin this study and are discussed below.

1.9.1 SYSTEM THEORY

The goal of the science of systems theory is the comparative analysis of systems. Systems come in several forms: machinery (especially computers), social networks, physicochemical systems, psychic systems, and organisms (including humans and their cognitive mechanisms).

The inflow and outflow of resources, that constitute either the outcome or a prerequisite of continuing system operations, link systems and subsystems. Each participant's rights and ideals, as well as their cognitive and motivational assets, are included in these materials. These various resource kinds are exchanged across systems through exchange mechanisms. It is essential to analyse these trade mechanisms because, without them, systems would struggle to obtain the necessary resources for their functioning.

1.9.2 CHANGE IN MANAGEMENT THEORY

Two connected concerns dominate management and organization theory: initially, it concentrates on procedures that develop over time, their management, and their evaluation. Rather than focusing on the discipline's supposedly more solid patterns, which dominated the second half of the 20th century, this viewpoint emphasizes the changing and fluid nature of management. The cognitive focus that many organization theories have embraced in recent decades is indicative of the second obsession. Most of the time, organizations are thought of as cognitive beings with human-like abilities to reason, acquire knowledge, and act. At the highest extreme, sensemaking methods actually proposed an almost fully corporealized and dematerialized picture of organizations: minds hovering in ambiguous regions lowered the imagined circumstances of their own cognitive presence without considering the materiality of the world.

Management thinking shifted its attention away from physical spatial and tangible reality, emphasizing instead, the processes that unfold over time and on cognition as the foundation of organizations. Researchers talked on power, change, and organizations without making reference to the spatial, material reality that made up these phenomena. They did this while largely neglecting the physical reality of organizations, particularly their spatial aspects.

1.9.3 ETHICS THEORIES

Since ethical theories reflect the perspectives from which people seek direction when considering options, they contribute to the foundation for decision-making when ethics are at stake. Each theory places emphasis on distinct ideas, decision-making processes, or guidelines for making decisions, such as projecting the future and abiding by one's obligations to others in order to arrive at a decision that one believes to be morally just. Different people make decisions differently, based on different facts and regulations. This is essential to their understanding of ethical decision-making. It is necessary to have some awareness of the common objectives that effective decision-makers strive to meet in order to better comprehend ethical philosophy. Beneficence, least harm, respect for autonomy, and fairness are four of these objectives.

Theoretical frameworks

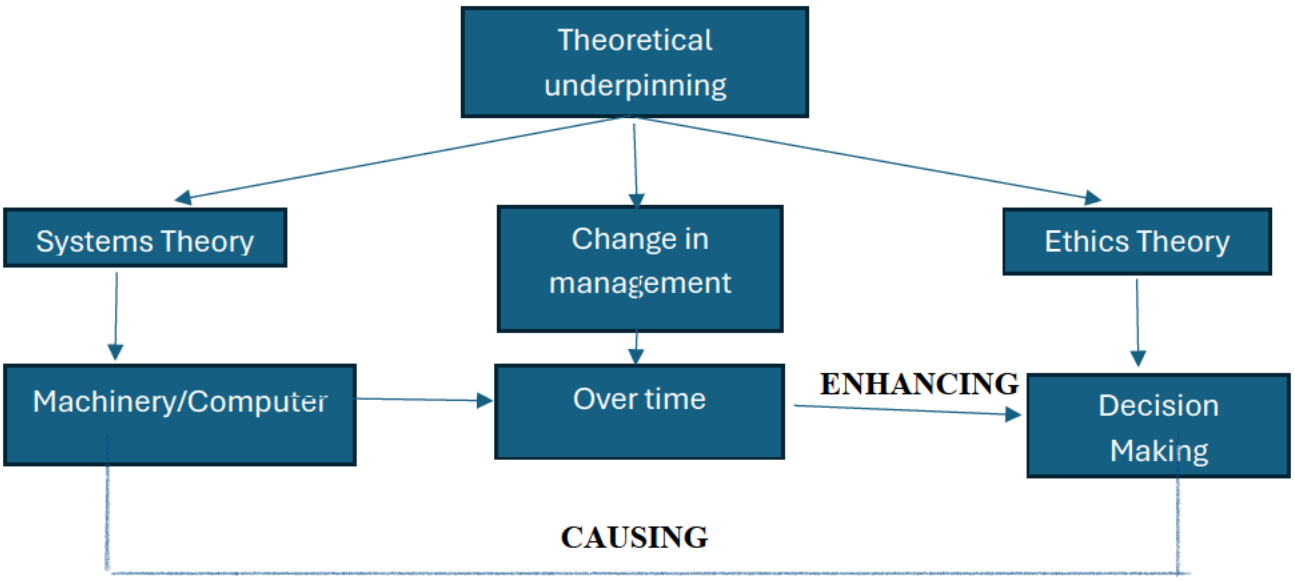


FIGURE 1.1 THEORITICAL FRAMEWORKS

1.10 DEFINITION OF TERMS

1. Construction supply chain is defined as a network of activities or milestones in a construction project through upstream and downstream routes connecting assorted processes and action that add value in the form of commodities and services required by the client (Dissanayake, Sandanayake and Wijekoon 2014).

2. Project tendering is the process of obtaining goods, supplies and services for construction project's delivery (Brook, 2016).

3. Project budgeting refers to the total amount of money that is reserved for project implementation (Miller, Howe and Sonenberg 2017).

4. Experience is a direct observation of or participation in an event based on already acquired knowledge (Welker *et al.* 2020).

5. Corruption in construction is defined as the misuse of an official position, rank or status by an office bearer for personal gain, not taking into consideration the needs of people to be served by the project (Nordin, Takim and Nawawi 2011).

6. Trust is the assured reliance on the character, ability, strength or truth of someone or something(Webster and Watson 2002). Trust is established to provide legal protection for the trustor's assets and to make sure that services are delivered.

7. Project commitment is the acceptance of and fortified belief in the goals and values of the project with a desire to pursue the project (Wang *et al.* 2018).

8. Resource allocation is the process by which the organization decides to allocate the adequate resources for service delivery (Janse, 2020).

9. Contract management is the management of contract made with clients, contractors and professionals or employees (Wikipedia, 2019).

10. Financial management is the process of organizing, controlling, monitoring, and planning financial resources with an aim to deliver its objectives (Funders NGO, 2020).

1.11 THE ASSUMPTIONS

Based upon the problem and sub-problems set for the study. The following assumptions were drawn:

- Firstly, the level of client sophistication with respect to the supply chain at the tendering stage.
- Secondly, the tendering staff level of competency at project tender stage.
- Thirdly, the stakeholders supply chain affects construction tendering, and
- Fourthly, trust and commitment factors affect project tendering.

1.12 PREVIOUS STUDIES

Prior to 2020, several research studies on supply chain tendering have been done across the globe in various locations. Some examined the effects of the supply chain at the tendering stage and will be discussed in the subsequent section.

In their 2013 study, Rahim and Wan Daud explored the factors influencing the adoption of E-tendering systems. They emphasized the critical role of tendering as a significant and expensive business activity in project management, noting that projects often allocate a substantial portion, sometimes as much as 70% of their useable fund to procuring goods and services. The gap between the studies by Babatunde et al. (2010) and Rahim and Wan Daud (2013) is 12 years which makes this study important as it will improve the understanding of tendering.

Table 1.1. Top 5 problems affecting construction tendering

Kioko and Were (2014)	Kiama *et al*. (2014)	Wanyonyi and Muturi (2015)	Love and Li (2000)	Babatunde, Opawole and Ujaddughe (2010)
Nairoby	South Africa	Kenya	Sub- Saharia	Nigeria
Physical facilities	Appropriate times	Tendering operation	Tendering techniques used	Implementation plan
Security	Appropriate purposes	Monetary value	Client specification	Industry type
Schooling	Fair rates	Adhering to the established procedures	High degree satisfaction	Allotted time
Health	Level of quantities	Subpar performance	Type of project	Budget

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter covers issues that can improve supply chain processes at the tendering stage in construction. Factors that influence the supply chain processes at tendering are discussed. The review of literature reveals that there are numerous tendering systems and tools in the supply chain market that can be used to support the execution of construction project tendering (Gibbs *et al.* 2015). These factors influencing the improvement of supply chain processes are addressed, and each factor is reviewed to mitigate the risk involved in the supply chain during the tendering stage of the construction projects.

2.2 TENDERING PLANNING

There is minimal doubt among policy makers, managers, professionals, and academics about the importance of tender planning for construction projects in both developed and developing countries Basheka (2008). The evolution of a tender plan must draw on the changing nature of criteria for demand and spot market rates (Bonser and Wu, 2001). Bonser and Wu (2001) state that the tendering method must be able to benefit from advantageous spot market prices as well as persuade the pre-negotiated contractual volume obligations.

Tendering planning refers to the process implemented by companies or public institutions to plan the acquired activity for a specific duration Ogubala and Kiarie (2014). In the construction business, yearly tendering planning can have two basic approaches, namely, myopic planning and static planning (Bonser and Wu, 2009). The myopic planning approach is a tendering decision that is made at the last moment, which allows managers to take into consideration up-to-date demands and spot market price data (Bonser and Wu 2001).

The static planning approach refers to the detailed planning at the beginning of each year to determine the monthly tendering plan (Bonser and Wu 2001). The tendering planning approach can positively impact tender planning. A tendering plan is influenced by several factors, which consider the value of tender process, the kind of tender, tender sensitivity (unique and high risk) strategic implication to the tender entity's prosperity and the nature of tendering, such as intrinsic risks and ethical and process issues (Ogubala and Kiarie, 2014). There is a need for tendering planning as it assists procurement entities or departments to fulfil their requirements

and needs in terms of tendering and hence achieving their service delivery objectives (Apollo, Onyongo and Ochieng 2014).

The KZN DPW, as a public organization, is necessary to deliver the necessary amenities in an effective, reliable, and quick manner (Standard Operation Procedure (SOP), 2013). A well-managed infrastructure asset assists organizations in achieving these objectives by building the connections and physical spaces necessary for the organization's services to be delivered (SOP, 2013). Planning procedures used by the public sector to convert policies into lengthy-, medium-, and immediate objectives as well as to prioritize and arrange those goals are changing. The government's endeavors to enhance long-range planning and unite the country around shared targets and schedules to propel forward motion in the long run are embodied in the creation of the National Planning Commission (NPC). (SOP, 2013).

The head of accounting of a company is required by the Public Finance Management Act's (PFMA) guidelines to produce a strategy plan that aligns with both the medium-term plan of operation and the medium-term expenditure framework (MTEF) in accordance with the organization's yearly performance objectives. The regulations mandate that strategic programs include, inter alia:

(i) Stay within the institution's announced MTEF expectations and span a minimum of three years.

(ii) Incorporate certain legal, functioning, and policy directives as well as constitutional ones that specify the results or commitments that the organization is in charge of.

(iii) Take into account policy and law advancements that have an impact on MTEF-based program planning.

(iv) List the program's quantifiable goals, anticipated results, program effects, markers (evaluates), and goals for the organization.

(v) Provide information about anticipated expenditures on capital, the repair and upkeep of tangible assets, and potential purchases of fixed or moveable capital possessions.

(vi) Provide information about planned transfer of capital or purchases of monetary assets, as well as strategies for managing those obligations and assets.

(vii) Provide information regarding the service delivery reform program, estimated proceeds from the disposition of resources, and multi-year income predictions.

Yearly the annual budget is finalized for the current financial year, while the MTEF is set up on a continuous recurring schedule for the following three years. Every year, the Minister of Finance presents an MTEF and a yearly spending plan to Parliament as the results of the ongoing medium-term budgeting procedures.

2.2.1 Alignment between the Infrastructure Planning and Budget Cycles: The Alignment Model

In order to enhance organizing and effectiveness in the provision of facilities the alignment model was created. This involved modifying the schedule of the infrastructure delivery cycle to incorporate the proper procedures and establish the vital connections among the MTEF budget cycle and the infrastructure delivery cycle. The infrastructure cycle's procedure, approximate duration, and relationship to the budget cycle are depicted in the alignment model.

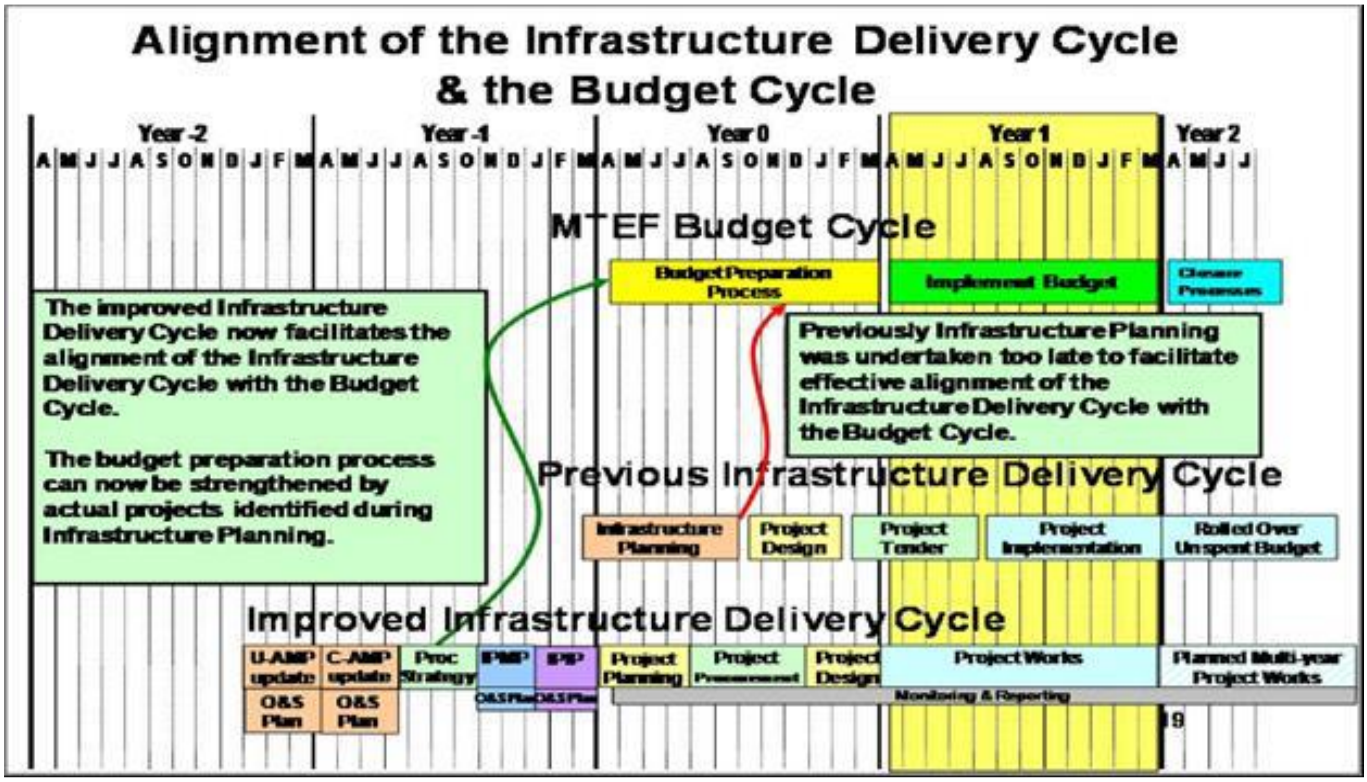


Figure 2. 1. The alignment of the Infrastructure Delivery Cycle with the MTEF Budget Cycle.

The cycle for delivering infrastructure is multi-year, with a fresh cycle beginning every year. As a result, the cycles coincide, and at any given year, officials will be preoccupied with tasks related to many infrastructure construction cycles, each of which is in a distinct phase.

2.2.2 MINOR NEW WORK (MAINTENANCE AND ADAPTATION: CAPITAL)

Minor new work is defined as the erection, construction, acquisition, extension or improvement of any building, including semi-permanent internal partitioning and new fixtures; a bridge, pond, road or any other work or undertaking of a permanent nature that does not exceed R250 000 and does not appear in the major works programmed may be regarded as minor new work (KZN DPW SOP 2013). Regardless of whether the work is minor new work or a major work programmed, the proper tendering plan and all the legislation need to be followed.

2.2.3 VALUE OF TENDERING PROCESSES

This is the process where the owners can decrease the risk in a project by evaluating and picking out the contractors based on their ability to manage the construction project (Perrenoud *et al.*, 2009). Appointing a contractor with ccompetent management techniques ought to produce superior outcomes in terms of budget, time, quality, and customer satisfaction (Perrenoud *et al.*, 2009). This includes the methods, which considers price and other important considerations during the assessment and decision-making process to improve longevity and construction significance (Scott, 2006). Additionally, in the lower bidder process, the lowest bidder is chosen. Comparing the two methods, the best value selection method has several advantages, such as forcing the tendering team to agree on the key criteria at the early point of the tendering activity, focusing on quality and value, encouraging contractors to be innovative, and ensuring the proper selection of the best contractor to execute the project (Scott, 2006). All these processes influence the tendering processes of the construction project.

Unproductive and pointless expenditure is defined as spending that was unnecessary and might have been averted if proper tendering planning had been made. As projects are sometimes too easily placed on the overall KZN DPW planning list, no harm could be served by pointing out the content of the Treasury Regulations issued in terms of the PFMA, dealing with fruitless and wasteful expenditure (KZN DPW SOP, 2013).

2.2.4 TYPE OF PROCUREMENT

A construction project's procurement process is broad since it entails the coordination and accumulating of numerous distinct people, businesses, and firms to plan, oversee, and establish construction products like homes, offices, retail centres, highways, and bridges for “customers” (Rashid *et al.*, 2006). The term procures from which procurement is derived, translates to “to

obtain by care or effort", "to bring about" and "to acquire". Type refers to "organized method, approach, technique, process, or procedure (Rashid, *et al.*, 2006).

Conventional lump sum procurement methods accounted for 52.2 percent of all project types. Out of 161 projects, design and build accounted for 19.9% and construction management for 16.1% in South African construction industry (Love and Li, 2000).

A thorough analysis of the literature on procurement types reveals that, at the moment, no practical method is utilized or employed for selecting the best form of procurement from a wide range of options for completing a variety of building projects. The literature research also made clear that factors affecting the choice of procurement methods are present at every stage of the project (Thwala and Mathonsi, 2011). Thwala and Mathonsi (2011) claim that this makes the problem of bad contractual connections between the contract's parties even worse.

Systems for procurement can be broadly divided into two categories: traditional and non-traditional., as follows.

i. Traditional type

This type is referred to as "traditional" since it has been in the field of construction for several decades and is the sole option available to the majority of clients (Thwala and Mathonsi 2011). By using this kind of arrangement, the client and design advisor come to a mutual understanding for the design work to be done and the contract paperwork to be prepared (Thwala and Mathonsi 2011). After this stage is finished, the contractor is determined by on the owner's requirements, and the owner signs a contract with the contractor who was selected to set up the project's components. The design expert and the contractor are essentially the two parties to a contract that the client must fulfil. One of the subsequent three techniques is used to welcome tenders from this type of procurement system so that the client can receive a constructed facility:

(i) Open Tendering
(ii) Selective Tendering
(iii) Negotiation tendering

ii. Non-Traditional type

In delivery contracts, non-traditional procurement systems are believed to provide a number of advantages over conventional procurement agreements; however, the understanding of its dynamics and communication particularities is limited (Kwofie, Aigavboa and Thwala 2020). Kwofie *et al.* (2020) further assert that non-traditional procurement models are dynamic and always altering to adapt to shifting market dynamics. Supply chain linkages, intricacy, and customer characteristics are placed highly among the several elements that significantly affect the effectiveness of non-traditional procurement models, with communication challenges ranking highly among them. (Kwofie *et al.,* 2020). As non- traditional procurement models continue to gain traction in the global construction industry, it becomes increasingly crucial to delve deeper into their characteristics, interactions, and the environment in which they are communicated with and information is shared.

2.2.5 STRATEGIC SIGNIFICANCE TO THE TENDERING

The method of establishing uniformity and coherence of action that determines the long-term goals and overall plan or sequence of operation by which the tendering role fulfils its mission is known as strategic tendering (Masiko 2013). Tendering is one of the supply chain activities with the greatest potential to impact the construction industry (Ordanini and Rubera 2012). Ordanini and Rubera (2012) further mention that this operation needs to be strategized to make sure that the planning for tendering of construction projects works in favor of the project, some of which are cost reduction, inventory level optimization and contribution to the quality of the final product. Recently, some of the tendering strategies have become more complex since tendering has been radically affected by technology transformation, and as a result, tendering planning is one of the activities where internet-based plans have been applied. However, as far as technology has been affected, most of the public departments have not implemented the available technological systems. Strategic tendering has been seen as a tool to maximize the planning of tendering for construction projects (Masiko 2013).

Masiko (2013) further says that strategic tendering planning, on the other hand, examines the ways that greater shareholder value over the long term might be produced through the procurement of products and services, particularly the outsourcing of whole processes. It entails narrowing the pool of potential suppliers, working cooperatively to negotiate with them,

interacting with them in a quality manner, and establishing lasting connections with the top suppliers (Masiko 2013).

2.2.6 THE NATURE OF TENDER (INTRINSIC RISK, ETHICAL AND PROCESS ISSUES)

The nature of tender is the basic purchasing mechanism through which organizations procure goods and services from outside vendors (Apiyo and Mburu 2014). The nature of good tendering impacts the plan and will elaborate by outlining the procedure to appoint those suppliers contractually (Apiyo and Mburu 2014). According to Apiyo and Mburu (2014), the procedures will be identical whether starting an organizational tendering preparatory activity or a project tendering activity: establish what you need to buy first. Next, specify how those objects will be obtained. And lastly, arrange the delivery windows.

Procuring organizations should ascertain their tendering demands, which should align with the goals of their company, prior to initiating any tendering transaction (Apiyo and Mburu 2014). The procurement organization should determine whether a specific tender is required in this respect. The evaluation should consider how the suggested spending would support the entity's intended outcomes, how the buyer employs its finances responsibly and effectively, and its general procurement thought in compliance with the Public Procurement and Disposal Act.

2.3 COMPETENCY OF PROFESSIONAL TEAM

Since the supply chain management framework was established in 2003, there has been negative press regarding the realm of local government and the construction sector within South Africa. The primary cause of the supply chain oversight rules' non-contravention has frequently been attributed to the ineptitude of the individuals in charge of the chain of supply, which stems from an absence of instruction, illicit conduct, and a shortage of political resolve to impose conformity (Matolong 2015). According to Matolong (2015), the majority of supply chain management authorities were observed to be non-compliant because it was discovered that they had colluded with suppliers to buy inflated goods and services, costing the South African government between R25 billion and R30 billion yearly.

Any company must go through this important process of evaluating its suppliers when intending to do a construction project, mainly since between forty and sixty percent of service delivery are provided in the form of products or services (Chemjor 2015). Hence, the tendering

of the construction project requires a competent team to procure the project. One of the tasks carried out by tendering personnel is assessment of suppliers, and the accomplishment or the ineffectiveness of their performance is determined by how well it is carried out. Chemjor (2015) further states that many factors contribute to tendering staff incompetency in choosing the right service provider. Some of the factors to consider are lack of supply chain training, poor ethics within the tendering team and tendering code, ineffective communication and co-ordination and information sharing.

2.3.1 LACK OF TRAININGS

The Ministry of Finance communicated all tendering issues to government departments through circulars. Later, the government realized that this tendering method had different loopholes that imparted immense financial loss in public finances (Ateto 2015). Ateto (2015) further claims that the tendering system was noted to lack transparency, accountability, and fair competition. It was then realised that the tendering teams were not well trained; lacked, and tendering authorities lacked a professional body to supervise and enact sanctions (Ateto 2015). The Public Procurement Law, 2003 (Act 663) is an all-inclusive regulation created to address the deficiencies and organizational difficulties that came with public tendering in South Africa (Ameyaw, Mensah and Osei-Tutu 2012).

According to a World Bank study from 2003, between 50 and 70 percent of the South African national budget is tied to tendering; as a result, an effective public tendering system might guarantee value for money in government expenditures, which is crucial for a nation facing significant problems with growth (Ameyaw *et al.* 2012). The supply chain is full of obstacles and challenges like skewed selection standards and insufficient information sharing. The latter group includes obstacles like a shortage of resources and expertise needed for the tendering procedure. Training could be a key component of the solution in getting through these obstacles. (Saastamoinen, Reijonen and Tammi 2017).

2.3.2 UNETHICAL CONDUCT

The fundamental rules governing proper conduct in one's personal or professional life are known as ethics (Kaynak and Sert 2012). Chronic ethical behavior is linked to organizations and the capacity to contend globally by the supply chain team, while the edifice of such behaviour counts on organizational perceptiveness and ethical behaviour (Kaynak and Sert

2012). Kaynak and Sert (2012) asserts that the ethical behaviour of the supply chain employees should be reflected in the attitudes, convictions, and attitudes that the team shares. This culture is created by the behaviours that result from their interaction with one another, anecdotes, and tangible principles and ideals.

The basic principle of good tendering practice hinges on accountability and ethical conduct. Effective systems need to be in place to allow contracting firms to carefully use the fewest resources possible, aware that they are answerable to the general public. Competitive supply conducted ethically, ensures ethical tendering and equal treatment of all bidders irrespective of race, nationality, or political affiliation (Amemba, Nyaboke, Osoro and Mburu 2013). According to Amemba *et al* (2013), moral precepts or ideals that authorities adhere to in all facets of their employment are known as ethics. Sincerity, credibility, truthfulness, caution, equal treatment, confidence, respect, and persistence are all components of ethical behaviour.

Refusing to abuse one's position while preventing conflicts of interest are examples of ethical behaviour. Employees are not permitted to act dishonestly or unethically, nor to appear to act so. (Amemba, *et al* 2013). The public's impression of a trustworthy government is harmed by both. If you work for the government, you may have access to tenders and other private data that could influence an application for a contract or the procedure for making awards. (Amemba, *et al* 2013). Failure to appropriately handle confidential information could lead to legal to breaches and ethical violations. According to Section 40 of the Public Procurement and Disposal Act (2005), individuals or agents must not engage in corrupt practices during any tendering process. Should anyone violate this provision, they face disqualification from participating in the tendering process, and if already contracted, the agreement may be voided at the discretion of the tendering entity (Amemba *et al*. 2013).

2.3.3 TENDERING CODES

Tendering codes have multiplied not only at the company level but also in terms of tendering staff competency (Preuss 2009). Multinational firms have faced a variety of challenges lately to participate in corporate social responsibility (CSR), according to Preuss (2009). Tendering codes have emerged as a significant mechanism for companies to respond to these demands. Additionally, Preuss (2009) suggests that tendering codes may also influence employee competence levels.

A study done by Preuss (2009) emphasizes the importance of organizing research within a structure that permits codes to be categorized according to two important parameters: compliance and content specificity. Thus, a thorough code and a robust system for tracking can show that a business is proactively addressing corporate social responsibility. Contractor assessment at the prequalification stage is usually based on several criteria, which are guided by tendering codes (Jaskowski, Biruk and Bucon 2009). Jaskowski *et al.* (2009) further asserts that pre-qualification and proposal evaluation procedures need to be handled objectively and centered on dependable and credible information in order to prevent disagreements and objections from possible bidders. One of the most crucial things a construction user has to do to ensure a good project conclusion is choosing a trustworthy contractor. selecting contractors only based on bid prices—a practice that is widespread in many nations—often criticized as unethical behaviour in the purchasing profession is sometimes regarded as more ethical, possibly because quite often a larger amount of money is involved as well as the personal enrichments of the individual (Badenhorst 2014).

2.3.4 INEFFECTIVE COMMUNICATION

A major study titled 'Silence Kills' (Friesen, Hughes and Zorn 2007) identifies a few communication-related problems, such as incapacity, inadequate collaboration, and disrespect amongst the tendering team. According to Friesen, Hughes and Zorn (2007), while 53 percent of tendering teams and other health service providers had concerns about incompetence, most people were hesitant to talk about their worries due to the detrimental effect ineffective communication can have on the construction tendering supply chain. The supply chain and other tendering providers experience incompetency resulting from ineffective communication (Friesen, Hughes and Zorn 2007). The ability to attract, retain and develop talented employees is a key feature of a successful tendering stage (Joseph 2015). According to Joseph (2015), staff members are the most asset in the supply chain team. However, effective communication assists the team in being more productive. Employees are at the core of many entities, whether they are construction companies or trades. Their presence and contributions are very important in determining if the business will either succeed or perish. This can only be achieved if the staff is competent and maintains consistent, effective communication. A business might have an effective supervisor, an excellent vision, and a solid objective; however, if there is ineffective communication that implicates staff competency, the company cannot perform its

duties properly (Joseph 2015). To overcome poor communication, it is recommended that instead of informal verbal communication, documentation such as work procedures, manuals, charts, and guidelines be used (Makulsawudon, Emsley and Sinthawanrong 2004).

2.3.5 INEFFECTIVE TENDERING CO-ORDINATION

Tendering co-ordination refers to the relationships and interactions among different actors operating within the supply chain processes (Balcik et al 2009). Tendering co-ordination can be described as the framework that the client chooses for overseeing the development, design, and execution of the construction endeavour (Aibinu and Papadonikolaki 2016). Meeting the changing demands of the supply chain at the tendering stage can have an impact on tendering staff competency (Mayordomo, Martin and Varga 2018). Therefore, appropriate co-ordination of tendering systems must be increased to avoid a negative impact on staff competency (Mayordomo, Martin and Varga 2018). Many factors contribute to ineffective tendering co-ordination difficulties in the supply chain, which bring about poor competency among tendering staff (Balcik, Beamon, Krejci, Muramatsu and Ramirez 2009). Balcik, Beamon, Krejci, Muramatsu and Ramirez (2009) further argue that a deficiency of co-ordination has been demonstrated to raise stock prices, extend turnaround times, and degrade consumer satisfaction across supply chain participants.

The first step in the and emerging practices in relief tendering coordination are examined and focus is the placed on typical tendering coordination mechanisms to ensure the smoothness of supply chain processes in the tendering of construction projects (Balcik *et al.* 2009).

The supply chain process is clearly separated from the tendering information generated and distributed. Accessing the tender phase is often difficult to access due to a lack of co-ordination (Aibinu and Papadonikolaki 2016). Additionally, Aibinu and Papadonikolika (2016) assert that overall effective management of tendering is achieved via the emergent functionality if it is coordinated accordingly.

However, despite the attention given by past studies to tendering, there is a dearth of published works, especially international studies, regarding co-ordination, and tendering outcomes. According to Martinez-Castanon (2008), the tendering role inside an organization cannot be considered in solitude in the global building sector of today; rather, it must work in tandem

with the organization and ensure that the tendering tactics align with their overall competitive plan.

2.3.6 INFORMATION SHARING

Supply chain processes have a major impact on the appointed contractor's ability to meet a client's needs and reduce costs (Huang and Ganagopahyay 2014). Huang and Ganagopahyay (2014) state that a key step in this collaboration process is to share information among the supply chain procurement and tendering teams. In addition, Huang and Ganagopahyay (2014) view information sharing as a major strategy to counteract the effect on staff competency. The advances in information technologies make information sharing much easier and they have become key tools for managing supply chains at the procurement and tendering stages. However, sharing information through organizational channels has brought about new concerns for the construction industry (Huang and Ganagopahyay 2014). The subject of information sharing has regained the interest of both the private and public sectors within the construction industry (Li 2002). Li (2002) asserts that in contemporary times, there is a significant exchange of information occurring among clients, contractors, and professional team.

On the contrary, the study shows that increasing the physical movement of commodities via a supply chain is far more beneficial than growing the distribution of details, and there is a limit to the benefit of information sharing in the framework of a supply chain that enhances staff expertise (Raghunathan *et al.* 2001). Consequently, the lack of information sharing by the procurement and tendering teams can exacerbate incompetence (Raghunathan *et al* 2001). Supply chain refers to the synchronization between the movement of data and goods among clients, professional teams and contractors (Leung and Baccaglini-Frank 2016). To reduce employee ineptitude, the various supply chain participants must exchange data with the aim of managing their efforts (Leung and Baccaglini-Frank 2016). Practitioners and academics from a variety of fields are becoming increasingly interested in the additional advantages of information sharing in building supply chain networks beyond just improving team capability. Sharing information greatly lowers supply chain expenses, strengthens ties with partners, increases material flow, permits quicker delivery, and raises order fulfilment rates, all of which improve customer satisfaction, improve channel collaboration, and make it easier to gain a competitive edge (Leung and Baccaglini-Frank 2016).

2.4 EFFECTIVENESS OF THE TENDERING PROCESS IN THE KZN DEPARTMENT OF PUBLIC WORKS

Tender quality control systems are particular operational methods and procedures targeted at producing the financial viability or tendering success throughout the supply chain via tracking an action and removing reasons for subpar performance at an appropriate point of the quality loops (Siongok and Noor 2016). The quality of the tender in relation to the manufacturing facility is of analytic importance in determining whether it is possible to manage the construction supply chain successfully (Yamamoto et al 2008). The collection and processing of deliveries from individual produces is known as supply chain procurement, and it requires high-quality execution (Siongok and Noor 2016). Effective tendering is defined as a standard for purchasing goods and hiring out construction jobs,and such control is affected by time, cost, safety and quality (Gita, 2014; Woolham and Benton, 2013; Noble, 2014; Ambe and Weiss, 2012; Elisana and Weder, 2010).

Corruption and misconduct are widespread viruses that negatively impact public life in many countries around the world (Palozzi *et al.* 2019). Corruption could be reasoned as the superlative barrier to profitable and social evolution (Palozzi *et al.* 2019). Construction tendering carries a significant potential for engaging in deceptive behaviour, which could jeopardize the excellence and accessibility of the services (Palozzi *et al.* 2019). Purchasing inferior and inadequate items that are out of step with industry standards is one of the main effects of corruption in building project tendering (Palozzi *et al.* 2019). From the industrial age, the idea of a system of quality control for tenders was born (Siongok and Noor 2016). Supply chain departments of institutions need to establish an effective tendering quality control method to monitor the use of quality control measures in each individual tendering process (Siongok and Noor 2016).

2.4.1 TIME

Tendering is a tool that has been emphasized by professionals in the construction sector to help transform the mindset of the sector and enhance the way construction procedures are delivered (Lavelle and Bardon 2019). Lavelle and Bardon (2019) further state that tendering has been sluggish to take off in the building industry. Time is verified to be among the primary apparent motivations of tender implementation utilizing a relative importance index, and sustainability advantages are also acknowledged as being relevant (Lavelle and Bardon 2019).

Traditionally, most construction contracts are procured under the low bid system (Zhang *et al.* 2019). Given that the construction duration is typically indicated in the tender paperwork, the client's primary consideration when awarding a contract under the low bid approach seems to be the bidding price. Nonetheless, the importance of construction time has grown for all stakeholders in the industry (Zhang *et al.* 2019). Early finishing of a project can significantly increase a client's return on investment, whereas late project delivery typically results in lost business prospects, lost earnings, and, in the case of public initiatives, even societal or ethical issues.

2.4.2 COST

Cost estimation is an experience-based process and is impacted by prevailing market prices (Elhang *et al* 2017). The authors further note that construction practitioners are cognizant of precariousness, incomplete information and unforeseen variables that can affect construction costs. Precise and more dependable estimates of costs are produced by price estimators when they have a greater grasp of cost-determinants and combine this knowledge with sound cost forecasting procedures (Elhang, Boussabaine and Balla 2017). In the construction sector, a variety of cost estimation techniques have been used. The simple fact that the majority of these mathematical frameworks only take into account important variables that are easily quantifiable is one of their main limitations. But the majority of important variables that impact the project's expenses are subjective; these include the client's demand for timely completion of the project, the scheduling skills of the contractors, the procurement processes used, and the state of the market, which includes the volume of work being done. The time required to complete a given construction project and its cost are connected (Zhang *et al.* 2019). Standard literature on construction project scheduling shows that for a particular construction company, there is an ideal cost-time optimum for any construction project. The contractor would've had the smallest construction cost at this time. A number of elements, such as the building's cost per unit, price increases, and client contentment with the expenses are taken into account when awarding the project tender (Elhang, Boussabaine and Balla 2017).

2.4.3 SAFETY

Errors in judgment and negligence, an absence of oversight or resources to complete the activity properly, or a deficiency of expertise or education are the main causes of workplace accidents (Enshassi, Mohamed and Abdel-Hadi 2013). During tendering it is proper that

bidders prioritize safety measures on the project as bid evaluations need to be considered. Additionally, the authors assert that unsafe behaviour in development and building projects are the most important component contributing to site accidents thereby suggesting a deficient safety culture. On the other hand, mishaps or an absence of safety and health can either completely or partially jeopardize budget, schedule, and quality. In the building sector, safety and health are taken into consideration for three reasons: financial concerns, legal requirements, and human aspects. Environmental challenges and construction-related health and safety hazards are frequently connected (Enshassi, Mohamed and Abdel-Hadi 2013).

Kartam, Flood and Koushki (2016) examined the safety performance of contractors over a two-year period at 98 distinct construction sites. The study came to the conclusion that the best strategies to reduce injuries related to breaking guidelines are through managerial education and appropriate operational procedures. In the USA, an efficient construction safety and health program requires about 2.5 percent of direct labour costs, per a Business Round Table analysis (Construction Industry Institute, 2018). Numerous construction organizations have created effective safety programs that have produced outstanding results. Kartam, Flood and Koushki (2016) developed a training programme called One Hour for Safety Management to provide safety education and training for top management. The programme successfully attracted management's attention to safety issues in 100 companies.

According to Boadu, Sunindijo, and Wang (2021), health and safety (H&S) concerns affect a construction project at every level, from the beginning (tendering) to the operating stage. For example, studies have demonstrated that a large number of incidents at construction sites are the result of managerial choices made before work starts on the site (Boadu *et al.* 2021). According to studies, building clients particularly contribute significantly to H&S (Boadu, Sunindijo, and Wang 2021). Participation by the customer in H&S management surely lowers their overall risk in addition to lowering the frequency and severity of incidents (Boadu, Sunindijo, and Wang 2021).

2.4.4 QUALITY

Requesting for competitive, cost-based bids continues to be the primary method of project allocation in the construction sector, both in Australia and internationally, for traditional hiring of contractors (Hardie and Saha 2019). The term "design-bid-build" is occasionally used to characterize this procurement process. Predicted construction time may be included in these tendering procedures as an extra selection factor, but generally speaking, they lack an evaluation of the contractor's capacity to produce high-quality finished products (Hardie and Saha 2019). The authors go on to say that as a result, the lowest-bidder might not be able to provide the project's final users with the highest level of service and value.

The conventional method aims to control quality by either excluding all except recognized or "invited" tenderers or by having an engineer or other qualified individual independently oversee the contractor's work (Hardie and Saha 2019). Both approaches may provide challenges, as various studies have noted. Due to the exclusion of new contractors from the selection procedure, there is a danger of subpar work in the prior scenario of solicited tenders or preliminary qualification (Hardie and Saha 2019). In the second kind of architect supervision, there can be a deficiency in skills and the capacity to address problems that develop on site promptly, or there might be an acute shortage of experience with construction-related matters.

Three interrelated characteristics are recognized as determining how satisfied customers are with the construction project's end product: the level of craftsmanship of the finished project result, timely project completion, and the final price tag in relation to the budget. As is typical across numerous businesses, a customer's choice to purchase an item in construction depends more on the premise of the item than on the actual end result, making the quality criteria particularly challenging to evaluate.

Public tenders frequently encounter issues including the involvement of unskilled bidders, manipulated eligibility settings, or improper techniques for assessing the bids, which eventually contribute to poor work during project delivery (Hanák and Muchová 2015). These are some of the grounds as to why procurement agendas are primary risk factors for construction projects as the quality of the product must be good (Hanák and Muchová 2015). Inappropriate administration of tenders may be the outcome of poor quality of work as an

incompetent contractor may be appointed or a deficiency in experience among the accountable staff.

2.5 CORRUPTION CONSTRAINTS MILITATING AGAINST EFFECTIVE TENDERING SYSTEMS FOR THE DELIVERY OF THE CONSTRUCTION PROJECT.

Tender awarding processes in the construction business will take a longer period to process since all tender documents should be reviewed and some standard procedures are to be followed (Mohemad *et al.* 2010). Public government departments procure a sizable mixture and amount of projects from private entities to carry out their normal operational responsibilities and to implement various plans and policies (Padhi and Mohapatra 2011). Padhi and Mohapatra (2011) further state that there are many factors affecting tender awards, such as the type of proposals, the quantity of proposal review phases, the designated cost, and the pre-bid meeting.

2.5.1 NATURE OF BIDS

The South African ggovernment operates an open tendering system, which is the nature of bidding for most of the government construction works (Skirtmore, Drew and Ngai 2013). The basis for this open tendering process is catalogues of authorized contractors; the contender who best fulfils the conditions is given the contract (Skitmore, Drew and Ngai 2013). Regulatory agencies classify the government databases of authorized contractors based on their size and nature (Skitmore, Drew and Ngai 2013). There are three major categories: general building, civil engineering and electrical, and depending on the nature of the bid, corruption can militate during the tendering processes. This can attract corruption, as the bigger the project, the more stakeholders are involved (Skitmore, Drew and Ngai 2013). With the exception of normal inflation and adjustments to monitor access fees, South African tenders are often effectively net cost contracts (Nash and Nilsson 2015). The bidding corruption problems are widespread in South Africa, where income is small compared with costs (Nash and Nilsson 2015). In these conditions, bidders could call for a viability reassessment to make the proceedings for more subsidies or pull away from the bidder (Nash and Nilsson 2015).

If a bidder requests to pull back, the government has a choice of renegotiation or appointing another bidder, and during the negotiation processes, non-ethical practicality can invade. It has a call-off agreement with a rail management consultant to supply the required managerial

know-how in this situation (Nash and Nilsson 2015). The majority of building assignments are awarded through sealed-bid bidding, where the lowest offer is considered for award (Skirtmore 2002). Clients, owners, principals, or consultants increasingly choose the participants (tenderers) of construction contract tendering in front of the tenderer (Skirtmore 2002). This is to limit the number of bids that are considered for a tender to those that the bidder believes have the best chance of completing the work to a high standard and to reduce the costs associated with unsuccessful bids from those who are not as fortunate (Skirtmore 2002).

When all of the tenderers are eager to get the job and submit compelling offers, pre-selection of tenderers in this manner is acceptable (Skirtmore 2002). Because clients frequently employ competitive bidding as a method of awarding building or engineering endeavours, contractors are continuously in a position of putting out bids for work (Laryea and Lubbock 2010). Numerous variables, such as the price of assets, earnings, uncertainty, economic conditions, and the organization's particulars at the time of bidding, frequently have an impact on the tender that a contractor submits (Laryea and Lubbock 2010). In order to reply to calls to tender, secure contracts, and maintain their company, major contractors file multiple offers annually (Laryea and Lubbock 2010). However, according to the authors minimal empirical study is frequently discussed the type of tenders that contractors handle. Most investigators agree that it might be challenging to obtain information on tender awarding.

2.5.2 BIDS VECTOR

Many factors pertaining to the contractor, undertaking, customer, rivals, tender, and economic circumstances influences the bid vector, which is a significant and intricate procedure (Sonmez and Sozgen 2016). In the construction sector, most bid vectors are made unofficially according to experience, judgment, and perspective, notwithstanding the challenges of the bid choice procedure. In order to enhance the current bid decision-making techniques, a procedure built on a support bid vector and reverse elimination withdrawal is proposed (Sonmez and Sozgen 2016). The technique makes use of the bid vector's strong generalization qualities and aims to improve generalization performance even more by removing unnecessary input variables (Sonmez and Sozgen 2016). Vector theory has received significant attention from researchers following the development of electronic auctions on the Internet (Candale and Sen 2015). Numerous sites like vector bid offer different types of auctions to facilitate the trading of infrastructure construction projects. Candale and Sen (2015) further state that it implements a

large variety of combinatorial auctions and exchanges. Bid theorists have, of course, traditionally favoured pricing as it aligns with the bidder's governing strategies to submit bids based on their actual valuations for packages, particularly in simple private value assessments (Erdil and Klemperer 2010). Insufficient profits may stem from improper pricing strategies. Strong incentives for companies to merge or split can lead to situations that are hard to control, such as collusion. Collusion can occur with the cooperation of just two bidders, creating opportunities for them to manipulate the process for personal gain, including the use of "stooges" or fake bidders to influence outcomes (Erdil and Klemperer 2010).

2.5.3 BIDS DIVISIBLE

Strategic circumstances are diversified in the many bid formats such as discriminatory (pay as bid) and uniform price bid (Kastly 2011). The winning bidder would unfairly withhold some profit from any work he would obtain by not bidding his full estimated costs (Kastly 2011). A bidder should make an even bid below his cost margins at potentially key amounts, which could ultimately influence the market clearing price. Kastly (2011) further contends that, as a result, not every bidder will offer their exact marginal costing in both bids that are divisible. Comparing standard and discriminating bid forms with regard to consistency and returns is an experimental question, as demonstrated by Ausubel and Cramton (2002). In some cases, one format may be superior to the other for either goal (Kastly 2011).

In a divisible bid, a client offers some amount of a good for sale (Wang and Zender 2001). Once the bids are submitted, the stop-out price, which is the bid price at which aggregate demand equals the available supply, along with the individual bids, determine how the goods are allocated to the bidders (Wang and Zender 2001). Furthermore, successful bids are those that are placed at prices that are larger than or equivalent to the stop-out pricing. Winning bids in wholly discriminating bids are filled at the bid price, whereas all winning bids in uniform-price bids are restricted to at the stop-out price (Wang and Zender 2001). A determining factor of divisible good auctions is that bidders are allowed to submit multiple price/quantity pairs as bids (Wang and Zender 2001). Actioning divisible goods is commonplace, notably in markets for financial securities, infrastructure, and environmental permits. In these auctions, bids explicitly state the quantities of the divisible items being offered (Ausubel and Cramton 2004).

Kasly (2005) developed an estimation know-how for a pure common value share auction. The estimation procedure includes two steps: the first step estimates the arrangement of the bid purpose, and the second step estimates the vector of parameters of the arrangement of signals using the expanded approach to moments (Kasly 2005). Lastly, they choose an equilibrium where the approaches are linear functions of the private signals in order to assess the counterfactual income from the uniform price auction.

2.5.4 BUNDLE OF BIDS ALLOWED.

A bidder can express collaboration among items and potentially impact corruption by managing multiple tenders simultaneously by submitting bids on group or bundles of bundles of projects and winning either all or none of the items in a bundle.

A bidder can express collaboration among items and potentially impact corruption by managing multiple tenders simultaneously by submitting bids on groups or bundles of project and winning either all or none of the items in a bundle (Elmaghraby and Keskinocak 2013). For these reasons, corruption in the South African construction industry has increased of late. While the capacity to submit bundle bids would appear to be a great disadvantage in tender awarding, surprisingly, in many applications for construction projects, most bidders do not submit bundle bids (Elmaghraby and Keskinocak 2013). The differentiating feature of a combination of bids is that the number of possible bundles is exponential in terms of the number of items. Elmaghraby and Keskinocak (2013) state that in addition to the complications of knowing the valuations of all possible bundles, the bidders face the problem of deciding which bundles to submit. According to Elmaghraby and Keskinocak (2013), evaluating and submitting all possible bundles would be prohibitively time-consuming for both the bidders and the client, potentially affecting tender awarding.

It is common for the purchasing company to procure multiple products simultaneously. For instance, the purchasing department of an automobile manufacturer must choose appropriate suppliers for multiple auto parts and components simultaneously. A synergy effect may exist between different combinations of products. It is advantageous for the purchasing company to consider the synergy effect between products to reduce costs and improve efficiency. On the other hand, suppliers need to consider the synergy effect between products to increase their chances of winning bids. For instance, a supplier could offer a larger discount for products with

complementary synergy. It is important to incorporate the synergy effect between products into the supplier selection problem. The automation model can help the decision-maker make the right decision in the multi-product supplier selection environment. (Chunxia and Wong 2015). Although a conventional tender can be for a single project at a time, bundle bids sell multiple goods with interdependent values simultaneously and allow the bidders to bid on any combination of goods (Yokoo, Sakurai and Matsubara 2000). Although the Internet provides an excellent infrastructure for executing bundles of bids, the possibility of new types of cheating must be considered. For example, an agent may try to profit from submitting false bids under fictitious names (Yokoo, Sakurai and Matsubara 2000) The authors contend that such dishonest bids are very difficult to detect since identifying each participant on the Internet is virtually impossible. Such bids made under a fictitious name are termed false name bids.

2.4.5 RESERVED PRICES

Bid average methods (BAM) award procurement contracts based on the reserved price budgeted by the client at the tendering stage (Spagnolo, Albano and Bianchi 2006). According to the advocates, the main reason why the BAM system is becoming popular, is the reserve price competition, which reduces the likelihood of cost overruns and the consequent costly renegotiations at the tender awarding stage. Additionally, the method can be viewed as two main tender awarding rules: in the first, the bid closest to the average wins; in the second, the winning bid is the one closest and below the reserved price (Spagnolo *et al* 2006)

When considering both the pricing and technical elements of a public procurement, the procedures of selecting the winning proposal from the tender can often prove to be quite complicated (Falagario, Sciancalepore, Costantino and Pietroforte 2018). Due to the unusually large volume of bidders (typically one project or service for each tender), the award deliberation procedure may be costly and time-consuming (Falagario *et al*. 2018). The delay in tender awarding happens when inexplicit and qualitative information, such as enhancement plans, quality, and performance, must be considered. Falagorio *et al*. (2018) state further that there may be a conflict between the desire for openness and evaluating a potential contractor based only on their reserve price and their ability to meet technical criteria. An impartial evaluation helps avoid situations when a dishonest bid judge unfairly favours one bidder at the expense of rivals (Falagorio *et al*. 2018). In supply chain procurement processes decisions on tender awarding must be based on a strict and unquestionable reserve price; consequently, the

tender awarding method should have the largest possible degree of objectivity (Falagorio *et al*. 2018).

2.5.6 NUMBER OF BID EVALUATION STAGE

One of the greatest restrictive duties that clients do is bid valuation in order to identify qualified contractors and choose the best offer among possible tenderers (Glas 2018). Crucial bid evaluation guarantees that the selected contractor can deliver successful construction projects fulfilling clients' objectives, while keeping to project cost, time and quality (Glas 2018). Building contracting is regarded as a highly risky and competitive industry because multiple tenders are competing for a single project (Hampson and Kwork 2017). The intense completion primarily stems from cost traditionally holding significant weight in the tender selection process. This often leads to delays in awarding tender, as the greater the number of tenders, the more extensive bid evaluation are necessary. A recent survey in the built environment has overpoweringly shown that contractors and subcontractors determine the industry's success by their company's ability to be the lowest cost tenderer; 75% of bid respondents ranked their ability to submit the lowest price as the number one reason for tender award success. Hampson and Kwork (2017) further state that the narrower the profit margins and the sharper the tender price, the more competitive the industry. Everyone agrees that a fixed-price tendering process can be detrimentally compromised. Contracting firms search for a competitive advantage that increases their market share of project awards. (Hampson and Kwork 2017).

Competitive tendering and awarding contracts to lowest tender are common practices in the construction industry worldwide (Glas 2018). This approach forces bidders to lower their prices and quote unrealistically low prices to win bids. This method is among the main reasons why projects fail (Glas 2018). There has been a notable change in studies within tender assessment in the previous years. Recent research has focused on the use of multi-criteria evaluation techniques for bids, with most researchers identifying and incorporating different criteria (Glas 2018). When reviewing tenders, clients consider a variety of factors, including their financial ability, technical proficiency, management aptitude, and reputation; nevertheless, these factors are often just utilized to generate a shortlist of offers (Glas 2018). Tender price is frequently the only factor considered when choosing the winning bid; as much as the tender price can be seen as the final decider, the awarding process can be too long as many tender quotations can be equivalent to each other. Therefore, it is advised that the assessment of tenders be a multi-

criteria process and that the selection of contractors should depend on more factors than only bid price or cost (Glas 2018). The length of time it takes for a tender to be awarded is determined by the qualitative and quantitative performances as determined by the engineers' or quantity surveyors' laborious evaluation procedure, and generally, the turnaround time can be implicated by the number of tenders submitted (Abas 2016).

2.5.7 PRE-BID MEETING

The execution of service procurement has an essential and important function in achieving organizational objectives (Nurmansyah and Hariyati 2021). This is consistent with the trend of considering procurement as a strategic endeavour rather than just a technical bureaucratic one. Additionally, as Nurmansyah and Hariyati (2021) further assert, government procurement of services contributes a crucial role in state and government endeavours by enabling working units within state agencies or local agencies to meet their budgetary requirements and achieve their objectives, and it is very important that briefing sessions are conducted to make sure that all unclear issues are clarified (Nurmansyah and Hariyati 2021).

The steps used in the typical building purchasing system to generate a cost estimate that serves as the foundation for a tender can be divided into four separate but related areas of work: the pre-bid meeting or project enquiry stage; creating a method statement and construction plan; creating a tender estimate; and, finally, the estimator's report and adjudication decisions (Pearl, Bowen and Hall 2014). The pre-bid meeting is important to make sure that all tender requirements are clarified to all bidders, which helps minimize tender awarding (Rakel and Gerzet 2011).

2.6 THE POLITICAL CONSTRAINTS AND UNETHICAL PRACTICES.

The political constraints that hinder popular support for the tendering process in transition economies rise and fall with unemployment and job creation (Dasia and Olofsgard 2019). However, empirical evidence implicates the link between the economic effects of reforms and the level of support for the delivery of the construction project, as unethical political decisions can influence unethical practices in the process. During the tendering process, political influence must be avoided, as it can be one of the main drivers of unethical conduct on the tendering team, such as money laundering, conflict of interest, corruption, and bribes (Dasia

and Olofsgard 2019). Political processes that create benefits for individuals do not bring freedom to the delivery of the construction project.

2.6.1 MONEY LAUNDERING

The sub-regime governing the global financial circulation is gaining traction and extending beyond drug trafficking to include other types of illegal activity as the laundering of proceeds from crime rises (Zigaris and Castilla 2018). Numerous investigations have discovered several types of misconduct since the construction business has a high prevalence of corruption. According to an OECD assessment from 2014, one of the main obstacles to long-term socioeconomic and political progress in industrialized, developing, and rising economies equally is corruption (Darko, Chan and Owusu 2018). In addition to increasing inequality and decreasing efficacy, corruption is projected to cost more than R2.6 trillion annually roughly 5% of the world's GDP—and to result in more than R1 trillion being paid in bribes each year. It has been found that the most frequently stated type of corruption in the sector is bribery, and this study aims to mitigate such practices by introducing the tendering automation system (Darko *et al* 2018). As a result, bribery through money laundering has been considered the main type of corruption that still occurs in the construction industry during tendering. However, as corruption has evolved over time, new types of corrupt methods have appeared, and more cash is being invested in these novel forms (Darko, Chan and Owusu 2018).

2.6.2 CONFLICT OF INTEREST

Conflict of interest often arises in construction procurement and is typically defined as dispute between the client organization's and the individual's aspirations of its officials (Ameyaw, Parn, Chan, De-Graft, John and Darko 2018). Power is similar to a conflict of interest in public service, position, or prestige (Rozzani and Rahman 2013). Since each government employee has a great deal of authority and responsibility, it also influences other employees' moral judgment. The writers go on to say that it creates a conflict of interest for the person in control when they choose to make a decision based on their own judgment or allow their environment influence it. When a decision-maker's personal, professional, or other passions collide with legitimate ones throughout the process of deciding, it is called a conflict of interest. It occurs when a person with the authority of a politician has the choice to take action on a matter that needs to be made, ultimately serving the interests of that person rather than the organization (Rozzani and Rahman 2013). It is not disputed that politics plays a role in government when it

comes to providing public services. Politics is a topic of popular interest, particularly when governments are making choices (Rozzani and Rahman 2013). The government always claims it was for the growth of the country, it could be for political interests of the governing party. This concern widens, as suggested by Rozzani and Rahman (2013), because, due to the increase in political intervention in recent years, public services' operations have since been compromised and their ethical positions have been weakened. Political intervention has the potential to trespass upon the normal and legal process of selecting contract and promotions for staff. This is due to the increasing size and influence of ministers' political staff which has further weakened the ethical process of public service operations.

2.6.3 CORRUPTION PRACTICES

Corruption is defined as the misuse of entrusted power for private gain (Emayaw, Parn, Chan, De-Graft, John and Darko 2017). Corruption represents a major and persistent obstacle to governments and businesses that seek to achieve sustainable social and economic development (Pillay 2018). According to the World Economic Forum (2012), corruption accounts for ≥ 5% of the world's gross domestic product, which translates into some US$2.6 trillion, with over US$1 trillion paid in bribes annually. The construction sector has been described as an inherently dishonest industry (Kimeu 2014), and corrupt practices occur at all stakeholder levels and phases of project development (Lim *et al.* 2015). These malpractices include fraud, fronting, bribery, kickbacks, conflict of interest, collusion and bid rigging, nepotism, and other unfair or unethical conduct (Lim *et al.* 2015).

The consequences of corruption include hindered economic growth, a lack of competition regarding prices and quality, and substandard craftsmanship (Uneke et al. 2010). The industry's vulnerability to corruption is due to its unique characteristics, such as the scale, distinctiveness, and complexity of construction projects; prolonged and intricate building processes; a fragmented structure with numerous contractual relationships; a confrontational culture; and weak ethical standards among professionals (Shan et al. 2015). Various forms of fraud and corruption occur within public sector entities, and it could be argued that these practices are possible in almost every sphere of activity and type of transaction (Mantzaris 2014). However, in many nations, particularly those that are developing, corruption is most prevalent in procurement activities. This is largely because procurement offers the greatest opportunities for corrupt behaviour and the potential for substantial rewards (Mantzaris 2014).

2.6.4 BRIBERY

In the fields of architecture and construction, the immeasurable worth of human life requires the utmost ethical standards from those whose actions may jeopardize it (Xue et al. 2018). Thus, engineers, architects, project supervisors, and builders possess a fundamental right to professional integrity (Xue et al. 2018). A key component of ethics in the construction sector is "personal ethics," often seen by professionals as treating others with the same level of honesty they would expect in return (Xue et al. 2018). However, it has been argued that professionals often prioritize their duties to clients over their obligations to others, such as the general public (Xue et al. 2018). Unethical behaviour, like accepting bribes, is said to stem not from one's upbringing but rather from the process of learning business practices or being introduced to industry norms (Xue et al. 2018).

Bribery within the construction sector can take various forms, including cash payments, gifts, favours, or entertainment. Other types include round-robin arrangements, work on private properties, extra jobs from clients, and complimentary travel—all of which can occur during bidding processes (Xue et al. 2018). Professional ethics encompass a set of standards that govern the moral principles and conduct of professionals in their everyday roles; therefore, officials engaged in tendering must uphold professionalism to reduce unethical actions like bribery (Ogbu and Asuquo 2018). In South Africa, legal and institutional frameworks for public procurement are increasingly being strengthened to combat corruption and unethical practices such as bribery. Measures include establishing an anti-corruption agency, and institutions for procurement management and financial oversight, like the Auditor General's office and the Treasury (Ogbu and Asuquo 2018). These initiatives aim to mitigate political issues like bribery. Additionally, laws like the Public Financial Management Act (PFMA) 1 of 1999 have been put in place to promote integrity, responsibility, and transparency in government procurement processes at all levels (Ogbu and Asuquo 2018).

2.7 THE BENEFITS OF AUTOMATING PROCESSES

The implementation of an automation solution that incorporates the proposed system into the enterprise's current tendering system can result in important advantages and additional revenue for the enterprise. These benefits include reduced costs, improved competitiveness through openness equal treatment reasonableness, and fairness, work flow efficiency, performance, throughput, productivity, efficacy, and complete transparency (Wasievw 2021). The

introduction of an automation system in construction tendering will result in faster tendering processes, fewer paper-based transactions, simpler transaction documentation, higher accountability, easier access to tendering materials, greater openness in the process, lower tendering costs, more competition among tenders, more inventiveness and creativity, and less corruption (Adedeji *et al.* 2017).

2.7.1 COST REDUCTION

Quick and cost-effective tendering and order execution processes are viewed as key competitive advantages in the construction sector (Willner, Gosling, and Schonsleben 2016). Automation must either be fully developed or tailored to meet customer requirements within the tendering or order fulfilment stages, as tasks related to design account for a significant portion of delivery lead times and expenses (Willner et al. 2016). Willner et al. (2016) also mention that strategies focused on computerized automation of design tasks—often known as design automation—are generally considered an efficient way to reduce lead times and costs while maintaining or even enhancing product quality during tendering. Since the 1970s, the electronics industry has used the term "automation" to refer to the automated design of circuits and microchips. More recently, this term has been increasingly applied to automating design tasks in construction, as it streamlines operations and helps reduce costs (Willner, Gosling, and Schonsleben 2016). Automating the tendering processes within an organization improves the ability to carry out more optimized and better-integrated tendering procedures. This study proposes a new systematic and comprehensive model to achieve objectives such as cost reduction in tendering (Qusef et al. 2019). Automating every step required in the tendering process will improve the overall workflow, making it easier to cut costs (Qusef et al. 2019).

2.7.2 COMPETITIVENESS ENHANCEMENT BY PROVIDING TRANSPARENCY

The automated tendering system will rapidly grow among the private and public sectors for its efficiency and convenience (Zubair *et al.* 2019). An end-to-end, fair and transparent tendering process is desirable for all stakeholders and a proper business environment (Zubair *et al.* 2019). This research will improve the quality of tendering, which includes transparency during the processes. Public tenders are essential to the functioning of the public sector and can be viewed as tools for improving public sector efficacy (Zabka, Pavela and Prokinova 2014). The automation of public tenders informed by the transaction costs theory and their relationship with transparency, further underscores this significance (Zabka, Pavela and Prokinova 2014).

Mwinamila (2013) emphasizes that effective transparent tendering process is the key to the success of institutions, whether they are private or public entities. According to Mwinamila (2013), any organization in need of supplies such as stationery, automobile accessories, equipment, consultancy services, or repair and construction works must ensure timely delivery of goods and services to user departments. This involves meeting the criteria of quality, quantity, timing, sourcing, and location.

2.7.3 EQUALITY

The coordinator, a municipality or authority, includes a provision in the call for tender that includes the following: the period, location, bidding method, technique, and time limit for submitting offers; the decrease in the service's start costs; and standards and restrictions for potential bidders (Uskov, Shariapova, and Ivanova 2020). The governing body must guarantee that fairness, inclusion, solidarity, and incorporation have been taken into account in all initiatives, regulations, services, and functions—both extant and anticipated (Taylor 2014). Equality refers to the equitable and fair treatment of tenders throughout the bidding process (Taylor 2014). Uskov *et al* (2020) discuss automation tenders for the development of the tendering system and integrating development of these system. The introduction of online bid submissions is a new model for land tenders, thus, principles for holding bidding tenders are put into question (Uskov *et al* 2020). The notion of tendering encompasses principles such as legality, fairness, equity, transparency, land use regulation, and public accountability. Advances in information technology are paving the way for automated tendering systems, including those used in the construction sector (Uskov et al. 2020). Contemporary software not only enables rapid searching and sorting of information but also automates alerts for new bids, auction terms, and bidder criteria. This reduces the shortcomings often associated with manual systems, such as maintaining fairness in the tendering process (Uskov et al. 2020).

2.7.4 PROPORTIONALITY

Corruption is not an unusual occurrence limited to unethical individuals committed to obvious wrongdoing (Diaz 2015). Regardless of societal stigmas, corruption transcends perceptions and can influence anyone and any procedure or contract to varying extents (Diaz 2015). The principle of proportionality should take precedence over the specific terms outlined in contracting documents, ensuring that the broader rules that govern them do not cause confusion (Diaz 2015). Therefore, the absence of this crucial and tailored application of proportionality

in the descriptive document does not mean it should be ignored. The fact that, to evaluate one of the exclusion grounds explicitly mentioned in the document, the contracting authority utilized the principle of proportionality though not explicitly stated in the descriptive document—is viewed by the Advocate General (AG) as being consistent with EU law (Diaz 2015).

2.7.5 PERFORMANCE

The government should leverage advanced internet-based technologies to simplify interactions with citizens and businesses, streamline procedures, and enhance communication between the public and government (Fong and Yan 2009). The objective of an automated tendering system is to eliminate unnecessary processes, greatly improve the quality of government services provided to citizens and businesses and boost overall efficiency (Fong and Yan 2009). Generally, automation should align with a government initiative that adds value to all tender participants, using internet technologies to simplify procurement activities for both buyers and suppliers (Fong and Yan 2009). The aim is to enhance the productivity and effectiveness of different tendering procedures by facilitating transactions between tendering partners and government entities (Fong and Yan 2009). Automation systems involve maximizing technology to deliver services and information, focusing on easing information searches, creating tenders, managing tender processes, and evaluating bids to optimize tendering outcomes (Fong and Yan 2009).

Tendering is a process where the responsible party selects a contractor or bidder to execute a task or supply goods or services by inviting several bidders to submit offers for the work, service, or supply (Sunmole and Shenu 2020). Due to its complexity, the tendering process often faces multiple delays (Sunmole and Shenu 2020). Increasingly, tendering is conducted online, referred to as electronic tendering or e-Tendering, which can handle the entire process from start to finish, albeit with certain limitations (Sunmole and Shenu 2020). e-Tendering primarily enables a more efficient way of sourcing suppliers by using internet-based technology to communicate requests for information and pricing to suppliers and to receive their responses. e-Tendering generally covers the posting of tender calls, the receipt of tenders, bid submission, and awarding tenders, all electronically and securely (Sunmole and Shenu 2020). The automation system will further improve tendering efficiency as it represents an

advancement beyond e-Tendering by transitioning to a fully automated process from start to finish.

2.7.6 EFFICIENCY

The high degree of division within the industry's demand and supply network where a wide variety of organization undertake construction work using various skill sets, processes, and technologies, continuously challenges the efficiency of information on tendering processing leading to low profit margins and fierce competition (Afolabi *et al.* 2017). At present, both the public and private sectors of the construction industry are increasingly shifting from conventional business practices to modern electronic business (e-business) methods. This transition is creating several distinct shifts: from paper-based to digital platforms; from local to global markets; from management-centred approaches to leadership-driven strategies; and from a reactive stance to a more proactive mindset—the use of the electronic system improves the efficiency of businesses (Afolabi *et al.* 2017). 'E-activities' typically involve addressing inefficiencies in traditional processes and communications and discovering more effective methods for performing tasks in a digital setting. These activities generally necessitate a commitment from industry organizations, along with changes and investment (Afolabi *et al.* 2017).

In many procurement situations, selecting the winning proposal can become highly intricate if both cost and technical criteria are taken into account (Falagamo, Sciancalepore, Castantino, and Pietroforte 2011). According to Falagamo et al. (2011), this complexity arises because the number of bidders often far exceeds what is necessary, with typically one service per tender. As a result, the decision-making process can become both time-consuming and costly. This complexity increases when dealing with vague and qualitative information, such as improvement plans, quality, and performance. Additionally, evaluating potential suppliers based on their ability to meet technical requirements through a purely qualitative assessment may conflict with the need for transparency and efficiency (Falagamo et al. 2011).

2.7.7 REDUCTION IN THE USE OF PAPER

Information technology-driven processes are propelling the construction industry into new realms (Lou and Alshawi 2009). The crucial factor for success is embracing change and adapting to new methodologies within this traditionally fragmented sector, which involves considerable development (Lou and Alshawi 2009). Organizations and firms must explore and

adjust to evolving conditions in the global economy to avoid financial losses and excessive paper use during tendering (Lou and Alshawi 2009). Companies are transitioning from outdated practices to more modern and efficient methods, primarily through digital platforms (Lou and Alshawi 2009). Data and information are now shared and disseminated electronically, creating a more cost-effective and efficient communication method while reducing paper consumption (Amit and Zott 2001). Electronic processes have the potential to create significant new wealth and revolutionize business operations in unprecedented ways (Amit and Zott 2001). The ongoing growth of e-business and online commerce offers opportunities for enhanced business processes that are more efficient and adaptable, cutting down on paper-based transactions, costs, and time. The internet-based collaborative environment represents one such opportunity (Lou and Alshawi 2009). Managing tender processes is frequently intricate and unpredictable, requiring coordination of numerous tasks and individuals with varying priorities and goals (Mohemad, Hamidam, Ali Othman, and Noor 2010). The introduction of automated tendering will increase efficient decisions from clients, consultants or contractors and minimize delays on tender awards and paper usage (Mohemad *et al* 2010).

2.7.8 REDUCED CORRUPTION

E-government involves more than simply providing computers to government officials or automating existing practices; merely using computers or automating complex processes does not automatically enhance government effectiveness or boost civic engagement (Hasani 2013). Relying exclusively on technological solutions will not alter the mindset of bureaucrats who see citizens as neither clients of the government nor active participants in decision-making. According to Hasani (2013), when implemented effectively, e-government leverages technology to drive reform by promoting transparency, bridging gaps and distances, and enabling individuals to engage in the political processes that impact their lives.

E-government can also lead to significant cost savings for both governments and citizens, enhance transparency, and reduce corrupt practices in public service delivery (Hasani 2013). It has the potential to address longstanding challenges and create unprecedented opportunities for sustainable economic growth, similar to the transformative effects it has had on businesses in the industrial sector (Hasani 2013). Automation not only offers the potential to collect, store, process and diffuse enormous quantities of information at minimal cost, but also global facilitates networking, interaction and communication. Moreover, it also reduces corruption practices within the construction industry (Hasani 2013).

The term corruption encompasses a range of activities. Scholars of corruption focus on different aspects, including bribery, kickbacks, breaches of ethics, unlawful asset accumulation, infractions of procurement rules, political favouritism, cronyism, breaches of campaign and party finance regulations, money laundering, illicit transactions, access to information, public administration, financial transparency, and various other related issues (Kimeu 2014). Automated tendering will mitigate most practices in the construction industry.

2.8 Conclusion

The purpose of this review was to view the factors affecting tendering in construction industry in composition of the case study at KZN DPW, within the past years tendering has been managed in construction industry. It is clear from the research reviewed that factor affecting tendering are influenced by type of tender and nature of tender as well many other factors mention on this chapter. Another reviewed factors are corruption and unethical practices. The literature also suggested the reviewal of benefits of automated tendering, such benefits are cost reduction, competition enhancement, equality, proportionality, high performance, efficiency as well reduction in the use of paper and reduction of corruption were found to benefits of automated tendering.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

As discussed in Chapter One, the main intention of this research is to examine the challenges of the supply chain at the tendering and procurement stages and to develop a model for the enhancement of processes. Choosing appropriate methods and procedures during research design is crucial to enhance the validity study. This chapter presents the research methodology used in the study to address the issue. It clarifies the research methodology, theoretical framework, and hypotheses, as well as the sampling strategy, data gathering techniques, and data analysis methods. This chapter is primarily organized to align with the steps involved in such a research study and is depicted systematically in the format of research processes.

3.2 DESCRIPTION OF RESEARCH

Applying the scientific method, this study meticulously examines the problem, concern, or subject with vigilance and comprehensiveness (Kowalczyk 2017). It is a systematic inquiry to describe, clarify, predict and control the detected phenomenon and also comprises inductive and deductive methods (Babbie and Babbie 1998). According to Pearce (2016) it refers to searching for and gathering information, usually to answer a particular question or address a specific problem. The purpose of the research is to discover new knowledge, describe, predict, and explain phenomena and enable theory developments (Goddard and Melville 2001).

3.3 CATEGORIES OF RESEARCH

The study incorporates two categories of research approaches, namely descriptive and experimental research.

3.3.1 DESCRIPTIVE RESEARCH

It can be characterized as a report of events as they happen, where the data is not controlled for variables. Furthermore, descriptive studies aim to define, describe, or identify 'what exists,' while investigative research seeks to determine why things are as they are or how they came to be (Dudovskiy 2018). According to Dudovskiy (2018), descriptive research is “aimed at casting light on current issues or problems through a process of data collection that enables them to describe the situation more completely than was possible without employing this method.”

The type of question that the study asks ultimately determines the type of approach that is necessary to complete and conduct the research. Descriptive studies primary concern is the exploration of what, how and why types of questions (Dudovskiy 2018). Descriptive studies can be either quantitative or qualitative and may involve gathering quantitative data that can be organized in a numerical format or scale (such as test scores or the frequency with which a person uses a specific feature of a multimedia application), or they may describe categories of information such as gender or patterns of interface use in group settings (Dudovskiy 2018).

3.4 RESEARCH PARADIGM

The research paradigm denotes the collection of shared beliefs and consensus among researchers regarding how issues should be interpreted and tackled (Patel et al. 2015). According to Chilipunde (2010), research can adhere to various standards based on the following central approaches: phenomenology, positivism, or the triangulation paradigm.

3.4.1 PHENOMENOLOGY PARADIGM

Welman *et al* (2005) stated that data observation does not represent authenticity but rather an interpretation of reality. Liu, Chiu and Fellows (2007) stated that a paradigm is a theoretical framework which involves a scheme by which people view events. Johnson *et al* (2007) and Alvesson and Karreman (2007) mentioned that cognitive processes naturally choose, restrict, arrange, and interpret experiences of the outside world rather than being passive recipients of sensory data. The authors go on to say that cultural legacies make it problematic to separate the data from preconceptions, particularly when it comes to philosophical dichotomy (i.e. the visible and invisible mind) and developments in technology. According to Deetz (2000), this postulates that reality is socially produced, meaning that interpretations of it are arbitrary, culturally and situationally based, and purposefully ideological.

3.4.2 POSITIVIST PARADIGM

The positivist paradigm approaches the social world based on the ontological belief that reality is external and objective (Chilipude, 2010). According to Chilipude (2010), this paradigm seeks to explore reality under the epistemological assumption that the physical sciences provide the basis for comprehending the social world. Consequently, the aim of conducting research is to uncover universal principles that govern underlying relationships through empirical investigations that are free from subjective values.

3.4.3 TRIANGULATION PARADIGM

Regardless of the type of research, emphasizing strength and impartiality is essential (Chilipude, 2010). This is exactly what the triangulation paradigm aims to achieve. Fellows and Liu (2012) define triangulation as employing two or more research methods to investigate the same phenomenon, such as combining experiments with interviews in a case study. The purpose of this approach is to overcome the limitations of both phenomenological and positivist paradigms while benefiting from their advantages, leading to a thorough evaluation of the topic that incorporates various perspectives (Liu, Chiu, and Fellows 2007).

3.5 RESEARCH APPROACH

Plans and actions for research span the phases of broad assumptions to comprehensive methods of data gathering exploration and interpretation. Cresswell and Eklund (2007) mentioned that the prominence of demonstrating the research method is an operative strategy to elevate the legitimacy of social research.

3.5.1 THE QUALITATIVE APPROACH

Qualitative research is primarily exploratory research, which is used to obtain an understanding of underlying reasons, opinions and motivations (DeFranzo 2011). Additionally, this kind of research is used to uncover trends in thoughts and opinions, enabling the data to dive deeper into the problem. Qualitative research focuses on understanding a research query as a humanistic or idealistic approach (Pathak and Limaye 2011). Pathak and Limaye (2011) noted that the qualitative approach is considered a more dependable method because it relies on numerical data that can be interpreted objectively and verified by other researchers. This method is employed to gain insight into individuals' beliefs, experiences, attitudes, behaviours, and interactions.

3.5.2 THE QUANTITATIVE APPROACH

Quantitative research is employed to quantify an issue by generating numerical data that can be converted into useful statistics. It is common to measure attitudes, opinions, behaviors, and other specific variables (DeFranzo 2011). This study adopts a quantitative approach as its methodology, aiming to enhance supply chain process during the tendering and procurement stages. It also involves revealing the various factors and challenges in the supply chain during the tendering and procurement stages.

3.6 RESEARCH PROCESS

The research process allows for the systematic workflow that is required to achieve the research objectives. The research process can also be defined as a simplistic way of efficiently tracing and finding information for the research study. This study is outlined in the following manner: identify the problem, review the literature, perform data analysis, and produce data reports, including clarification and reporting. The process involves exploring a case study of the automation of e-tendering in the KZN DPW to improve the supply chain processes at the tendering and procurement stages.

3.7 RESEARCH METHODS

The term "research methods" is broad and encompasses the fundamental techniques used for gathering and analyzing data. McCrindle (2011) introduced methods as techniques and tools that are required for doing research. Methods provide the researcher with the means to gather, sort and analyze the data. McCrindle (2011) stated that data comes in two forms, namely, primary data and secondary data.

3.7.1 PRIMARY DATA

Primary data refers to information that has not been previously observed or published (McCrindle, 2011). McCrindle (2011) further mentioned that primary data is collected for specific purposes and is analyzed critically to find answers to research questions. The data used in this study was obtained by surveying the prevailing literature concerning management issues in supply chain processes, the causes of improper supply chain issues at the tendering and procurement stages and their impact. There are four key segments of primary data:

- Measurement: the gathering of numbers representing amounts.
- Observation: the capture of events, phenomena or situations experienced.
- Interrogation: data acquired by probing or asking.
- Participation: data developed by experiencing something.

In primary data collection, the data is collected using methods like questionnaires, interviews, focus groups, observations, case studies, diaries and critical incidents (McCrindle 2011).

3.7.2 SECONDARY DATA

This refers to data that has been made available through journals, magazines, newspapers, books, online platforms, and other sources (McCrindle, 2011). Secondary quantitative research techniques and methods are often standardized, such as formulas for computing the mean, median, and mode of data sets. In qualitative research, each research question is addressed individually, and specific methods are developed to interpret the primary data, taking into account the unique aspects of the study (McCrindle, 2011).

Secondary data offers three advantages. It is:

- readily available,
- less expensive than primary data, and
- easily collected.

The secondary data for this study was gathered from numerous international and national sources, including journals, articles, theses, books, reports, conference papers and the internet. The primary data for this research was obtained by distributing questionnaires and conducting interviews.

i. Anonymity and confidentiality issues

There was no direct contact between the researcher and the participants, as the questionnaire was sent via email with a link to the government department to be distributed to the participants. Secondly, the questionnaire did not request participants' personal information, and they were not expected to disclose their personal information or any information that may lead to their identity being disclosed. In short, the study assured the complete anonymity of the participants within the KZN Department of Public Works.

ii. Data storage

The collected information will be coded, protected, and stored by the researcher with a password on an external hard drive and placed on locked archives only accessible to the researcher. The researcher will dispose of the stored and protected data by deleting the files after five years.

iii. Recruitment process

The recruitment of participants will be through a questionnaire distributed via the link to the KZN Department of Public Works. This department will distribute the questionnaire to its members who are potential participants.

3.8 PHILOSOPHY OF THE RESEARCH

The research philosophies or paradigms are based on three positions or assumptions. The first two are the ontological and epistemological positions (Ozumba and Ozumba 2012). The third, which is inevitable but least considered in most cases, is the axiological position (Ozumba and Ozumba 2012). Philosophical perspectives frequently influence the selection of research design and the methods used for conducting research (Adamu, Nganje, and Edet 2015). These philosophical viewpoints are often shaped by individuals' sociological backgrounds; however, in academic research, the nature and specifics of the problem a researcher identifies and aims to address dictate the researcher's philosophical stance and the methodology to be employed (Shakantu, 2004). The three philosophical assumptions are discussed in the following section.

3.8.1 ONTOLOGY IN RESEARCH

Ontology is a direct specification of a conceptualization (Ahmad *et al.* 2007). It is a design that is formally representative of the agreed semantics of a domain of interest in computer resources (Ahmad *et al.* 2007). This warrants the sharing and utilization of information and allows for the interoperability of information systems (Ahmad *et al.* 2007). Research on ontological conjecture answers the question of what is, or basically, what is trusted about the way the world is (Ozumba and Ozumba 2012). Therefore, ontology asks questions about what constitutes truth, reality or facts (Ozumba and Ozumba 2012). Ontology refers to the essence of information, questioning what could be possibly known.

Ontology is a prime emerging discipline with the possibility pf improving information organization, management and understanding (Foo *et al.* 2012). It plays a crucial role in ensuring content-based access, interoperability, communication, and delivering significantly enhanced services with the next phase of web evolution known as the Semantic Web (Foo et al. 2012). Addressing issues related to ontology creation, mapping, and upkeep is essential (Foo et al. 2012). Additionally, the surveys are divided into two sections. The first section examines cutting-edge techniques and research in semi-automatic and automatic ontology creation, along with the challenges encountered in these studies. The second section focuses on ontology

mapping and advancements in ontology (Foo et al. 2012). Ontology specifically concerns the nature of reality as perceived in people's minds, distinguishing between objective and subjective aspects of that reality (Adamu et al. 2015).

3.8.2 EPISTEMOLOGY IN RESEARCH

Epistemology in research focuses on knowledge, including its concepts, origins, and scope. It examines the reasoning and justification behind information (Adamu, Nganje, and Edet 2015). Essentially, epistemological perspectives in research address how knowledge is formed and the debates about the feasibility of acquiring knowledge (Adamu, Nganje, and Edet 2015). This field also provides insights into objectivity and subjectivism. Objectivists believe that knowledge about the external world can be obtained with minimal manipulation. Conversely, subjectivists argue that knowledge about the external world comes through observation and interpretation (Adamu et al. 2015).

While science and psychology claim their endeavors are objective and free of values, they often overlook that these claims themselves reflect a particular stance on the nature of knowledge, thus falling within the realm of epistemology (Jones, 2017). Jones (2017) also noted that although science or psychology may adopt the belief in a single, universal reality that can be uncovered through controlled investigation, they fail to acknowledge the human capacity to interpret and understand this reality.

3.8.3 AXIOLOGY IN RESEARCH

Axiology is concerned with the value system (Ozumba and Ozumba 2012). According to Ozumba and Ozumba (2012) axiology determines what is received or rejected, discernment, and hence judgements in social enquiry. As such, each research places varying values on data acquired through different approaches, methods and techniques (Ozumba and Ozumba 2012). Through the foundations discussed in the preceding sections, the paradigms or philosophy of the research can be properly constructed and presented, as depicted in the following sections. The role of values in research and the researcher’s stance sometimes cannot be separated, and so will be subjective (Dlamini, Franke and Vounatsou 2015).

3.9 RESEARCH REASONING

Reasoning is a process of thought that yields a conclusion from precepts, thoughts, or assertions (Liard, 2019). The term reasoning in academic research refers to the logic of undertaking research (Aduma and Ibekwe 2017). Adamu and Ibekwe (2017) highlighted that this involves the techniques researchers use to create or recreate knowledge. The primary methods are deductive and inductive reasoning. Deductive reasoning is largely shaped by positivist perspectives, whereas inductive reasoning is influenced by interpretivist perspectives (Adamu and Ibekwe 2017). These two main reasoning approaches are explored in sections 3.9.1 and 3.9.2, with the reasoning method used in this study detailed in Section 4.4.3. Research on moral reasoning has revealed a tension between normative conclusions and intuitive judgments (Adamu, 2017). This has led some scholars to suggest the presence of deontological moral principles, where certain actions are deemed immoral regardless of their outcomes, potentially hindering utilitarian objectives.

3.9.1 DEDUCTIVE REASONING

Deduction is explained as a reasoning approach that yields solid conclusions, which must be true given that their premises are true (Liard, 2019). Some deductions are difficult, albeit the business of life depends on the ability to make deductions. Two principal theories have dominated the cognitive research on deductive reasoning (Billger and Goel 2020). The main debate between these theories concerns whether deduction relies on a set of rules that are sensitive to the logical structure of the argument (mental logic theory) or if it involves creating and assessing a visuo-spatial representation of the argument (mental model theory). Billger and Goel (2020) noted that recent neuroimaging and lesion studies with neurological patients have produced intriguing results that should be considered in developing theories of logical reasoning. In academic research, the deductive reasoning method is a strategy where the researcher starts with broad, general information and progressively narrows down to more specific details. This deductive approach is also known as the “top-down” method (Adamu 2017).

3.9.2 INDUCTIVE REASONING

The ideal of perfect, logical, deductive rationality in economics is highly valuable for solving theoretical issues (Arthur 2014). However, Arthur (2014) pointed out that it demands far more from human behaviour than it can typically provide. If humans were to reason in this manner, how could this be modelled? In a scenario that unfolds over time, one might establish a group of agents, likely diverse, and assume they are capable of forming mental models, hypotheses, or subjective beliefs (Arthur 2014). These beliefs could be expressed as simple mathematical formulas to describe or predict a variable or action; complex expectation models similar to those used in economics; statistical hypotheses; or conditional or predictive rules (for example, if condition Q is met, then outcome or action D is anticipated). Inductive reasoning contrasts with deductive reasoning (Adamu 2017). As per Adamu (2017), this approach involves moving from specific observations to broader generalizations and theories. This method is sometimes called a "bottom-up" approach.

Inductive reasoning aims at gaining understanding and knowledge by establishing connections between observations and theories (Adamu 2017). It is used in science to develop theories that eliminate the need for constant observation, enabling generalizations about the future based on past experiences with a reasonable degree of certainty (Adamu 2017). Adamu (2017) also noted that inductive researchers strive to remain open to various possible outcomes while suggesting additional steps for data collection to address the phenomena under investigation.

3.9.3 REASONING STRATEGY

The use of an inductive reasoning method was required due to the unique characteristics of the study inquiry. Since the primary objective of this research is to gain a greater awareness of the phenomenon, inductive reasoning was employed to enable in-depth examinations (Arthur 2014).

3.10 POPULATION AND SAMPLING

3.10.1. SAMPLE

A sample in research refers to a sub-set of a population of interest (Ozumba and Ozumba 2012). As this is a case study of the KZN Department of Public Works on tendering and procurement, the sample consisted of professionals and all associated entities working within this department. Sampling is important as it was not possible to examine the entire population. The population of the study resides in KwaZulu-Natal, but the study aims to improve supply chain processes within the South African construction industry. The selection was based on the feasibility of achieving the research's aim. To meet the aim and objectives outlined, this study adopted the KwaZulu-Natal Department of Public Works.

3.10.2 SAMPLE DESIGN

A versatile technique for gathering data for study is sampling design (Jawele 2012). Research becomes challenging when it is not possible to investigate the whole population or globally. Next, the researcher might decide which subset of the entire population to include in the sample (Jawale, 2012). According to Leedy, Ormrod and Johnson (2014) the two major categories of sampling approaches are:

- Probability
- Non-probability.

Probability sampling ensures that every segment of the population is included in the sample. In this method, samples are drawn from the larger population using a technique called random selection, which gives each individual in the population an equal opportunity to be chosen (Leedy et al., 2014). Different strategies used in probability sampling include simple random sampling, stratified random sampling, systematic sampling, and cluster sampling:

- Simple random sampling involves selecting samples through a process where each member of the population has an equal chance of being picked.
- Stratified random sampling is applied when the population consists of various strata or groups. Here, samples are drawn equally from each group to ensure fair representation.
- Cluster sampling involves dividing a large area into smaller segments, such as regions or towns. These clusters should be as similar as possible and contain a diverse mix of

individuals. Samples are then randomly chosen from these identified clusters (Leedy, Ormrod, and Johnson, 2014).

In this study, the geographical focus is KwaZulu-Natal. The participants are individuals with training in fields related to the built environment, including supply chain management, quantity surveying, and architecture, all of whom have followed specific training programs.

3.10.3 NON-PROBABILITY SAMPLING

Non-probability sampling results in unequal representation of the population's constituent parts and little to no possibility of sampling for population members (Leedy, Ormrod and Johnson 2014).

3.10.4 PROPORTIONAL STRATIFIED SAMPLING

The primary feature of simple stratified random sampling is that all groups within the population are approximately equal in size. In contrast, proportional stratified sampling involves a population with distinct strata that exist in varying proportions. To ensure fairness in sampling, a method is chosen that avoids disadvantaging any particular group. It is assumed that every participant within each group has an equal chance of being selected. The choice of sample size is made in a relative manner (Leedy, Ormrod, and Johnson, 2014).

Systematic sampling is a technique where a researcher selects samples in a sequential manner. A list of units from the target population is compiled, and every nth unit on the list is chosen. For example, every tenth unit is selected and matched with the list to identify the individual, organization, or object to be surveyed (Leedy, Ormrod, and Johnson, 2014).

i. Sample stratum and sample selection

South Africa is divided into nine administrative provinces. KwaZulu-Natal has been used as a case study on the automation of tendering and procurement processes, even though the study aims to improve the supply chain processes at tendering and procurement stages in the South African construction industry.

The discussion combines the sample group and the determination of sample size, focusing on different professionals within the industry.

ii. Sampling respondents who are involved in the supply chain

All respondents involved in the supply chain cannot be surveyed because they constitute a very large sample size. To achieve fair representation, respondents in the KwaZulu-Natal Department of Public Works were chosen. Construction activity is high or average in this province.

Table 3. 1 : The size of each sample stratum within the total population.

Provinces	Number
KwaZulu-Natal	110

Proportional stratified sampling and random sampling were chosen to determine sample sizes. The population was categorized into alphabetical groups, and given this categorization, proportional stratified sampling was considered suitable for choosing the samples. According to Leedy et al. (2014), when a population includes distinct strata that exist in varying proportions, proportional stratified sampling is the recommended approach.

Sample sizes were determined using the following formula:

(Number of samples in alphabetical group) X (total number to be sampled) ÷ (total population)

$$\frac{\text{(No. of sample in alphabetical group) X (Total no to be sampled)}}{\text{(Total population)}}$$

A cardboard box with dimensions of 20 x 20 x 20 cm was used, containing pieces of paper numbered sequentially up to the sample size. The papers were folded and placed in the box, which was then shaken to randomize the contents. The required number of papers was drawn from the box, and each selected paper was matched with the corresponding name on the list of each group. These names were subsequently emailed to the respective organizations. The sample sizes for the institutions are displayed in Table 3.2.

Table 3. 2.: KwaZulu-Natal institute of respondent's sample

Alphabetic group	Formula	Sample
A to B	68 x 250/1000	18
C to E	84 x 250/1000	22
E to J	65 x 250/1000	17
K to M	73 x 250/1000	19
N to P	45 x 250/1000	12
Q to T	73 x 250/1000	16
U to Z	24 x 250/1000	6
Total		**110**

3.11 QUESTIONNAIRE DESIGN

Questionnaires are used as the research instrument and dispensed to the grade professionals within the KZN DoPW as well as entities involved in the construction supply chain at the tendering and procurement stages like consultants working within KZN DoPW. The questions were developed following a typical Likert Scale, using a five-point gauge. Questionnaires were used to interpret, understand and gauge the experiences of construction professionals relating to the supply chain processes at tendering and procurement, as well as to assess causes and impacts (Leedy 2014). The questions were designed to address this study's objectives and sub-objectives. Questionnaires are a reputed method of obtaining data from a large number of people or from people who may not have time to attend an interview or take part in experiments (Leedy, Ormrod and Johnson 2014). The questions presented in the questionnaires were designed to enable participants to take their time, consider them and revisit them later.

Participants could state their views or feelings confidently without worrying about the researcher's conceivable response. The questions were designed to encourage participants to answer the questions as honestly as possible to prevent the researcher from drawing false conclusions from this study (Leedy, Ormrod and Johnson 2014).

3.12 DATA COLLECTION

The questionnaires were distributed electronically, via email, accompanied by the letter of information and consent. Respondents were given the option to return completed questionnaires either electronically or as hard copies, whichever method suited them best. The entire process of distributing and collecting questionnaires was conducted with utmost morality, ethics, and sensitivity, ensuring that respondents were not coerced into participation (Leedy, Ormrod and Johnson 2014). Interview questions and physical interviews were held with respondents to collect data.

3.13 DATA ANALYSIS

The most appropriate measures are formulated to address the five-point Likert scale used in answering the questions. The configuration enabled the consolidation of most frequent response, displaying them as a percentage.

3.14 RELIABILITY AND VALIDITY

Assessing the quality of research is crucial if findings are to be exploited in practice and combined into normal guidelines (Noble and Smith 2015). Noble and Smith (2015) further mentioned that evaluating the dependability of study conclusions required researchers to make decisions about the accuracy of the research in relation to the application and suitability of the methods assumed and the veracity of the final inferences. Studies in general should be conducted in a valid and logical manner. The basis of the argument and evidence that supports the study should be logical and valid. Mouton (2001) says that, to collect data, some form of measuring instruments has to be used. These could be sophisticated instruments ranging from high resolution microscopes to gas spectrometers, or instruments such as questionnaires, observation schedules, interviewing schedules and psychological tests.

Leedy et al. (2005) highlight validity and reliability as two factors that are vitally important when considering the measurement of data:

- Validity is the soundness and the effectiveness of the measuring instrument. This refers to the functionality of the instrument and accuracy of the reading by the instrument, and
- Reliability deals with the accuracy of the measuring instrument and how dependable the data read or taken from the instrument are.

There are many ways in which the validity of a measurement can be tested. These include:

- Face validity: This is a subjective judgement and is given by the researcher.
- Criterion related validity: Judgment is made of the measurement based on the standards that have been set.
- Content validity: This is the accuracy with which an instrument measures the factors or situations under study.
- Construct validity: This is the extent to which the conclusions reached in a study is free from bias, and
- External validity: This is the extent to which the conclusions reached in a study are generalized and applied to samples in other cases.

Reliability refers to the extent to which assessments are reliable. Just as we seek dependable sources, we strive to have dependable, unswerving devices to measure research (Noble and Smith 2015). Validity refers to the accuracy of an assessment and whether it measures what it is supposed to measure. Even if a test is reliable, it may not deliver a valid measure (Noble and Smith 2015). The questionnaires were run through a pilot test, and the researcher judgmentally evaluated the questions in terms of their validity. The researcher ensured that the information gathered was accurate, the results were checked and tested, and the information was realistic.

3.15 LIMITATIONS

Participants possibly felt that their ranking reflected on their performance abilities in the tendering and procuring stage of projects. Site visitations were not possible due to a limited budget and COVID-19 prevented personal interviews. The automatic authentic of external regulatory institutions such as Construction Industry Development Board (CIDB) grading, South African Revenue Service (SARS) and Central Suppliers Database (CSD), as the case study is at the feasibility stage the automation is not yet able to automatically validate the requirements from external regulator institutions. The model also still requires human involvement on evaluation.

3.15.1 **Area for future study**

- Full automation of evaluation processes.
- Automatic authentication of regulatory bodies such as Central Supplier Database (CSD) and South African Revenue Service (SARS).

3.16 QUESTIONNAIRE DESIGN

Only the questionnaires were distributed, and the interviews were conducted after the research was approved.

CHAPTER 4: STATEMENT OF FINDINGS, INTERPRETATION AND DISCUSSION OF THE DATA

4.1 INTRODUCTION

This chapter presents the results and discusses the findings from the questionnaires used in this study, focusing on the development of an automation tender process for the KwaZulu-Natal Department of Public Works. The questionnaire, as the primary data collection tool, garnered 103 responses. The analysis of these responses was performed using SPSS version 29.0. This section will showcase the descriptive statistics through graphs, cross-tabulations, and other figures, representing the collected quantitative data. Inferential analysis methods such as correlations and chi-square test values are interpreted via p-values, where traditionally, a p-value less than 0.05 indicates statistical significance. The response rate and its implications for the study will also be discussed in detail.

4.2 SAMPLE FRAME

The composition of the sample frames included the KZN Department of Public Works and all entities that are involved in tendering and procuring construction projects. Therefore, in this case study, the sample consisted of the following professionals with KZN DPW: supply chain, quantity surveyors and consultants.

The composition of the public sector sample frame is presented in Table 4.1:

Table 4. 1 : Composition of the public sectors sample frame

Composition	Number
Department of Public Works	300

The composition of the private sector sample frame is presented in Table 4.2:

Table 4. 2 : Composition of the private sectors sample frame

Composition	Number
Contractors	100
Consultants	100

4.2.1 SAMPLE SIZE

Sample size indicates the number of respondents that are surveyed for this study. According to the CIDB registered contractors (2021), there are at least 4593 GB and 4556 CE registered contractors (all grades) in South Africa. This number makes it impossible to dispense questionnaires and accept responses from everyone. The larger the sample size, the more likely its average and standard deviation will accurately reflect those of the overall population. Additionally, a larger sample reduces the likelihood of obtaining misleading results or failing to uncover the truth. According to Leedy, Ormrod, and Johnson (2014), researchers should aim to maximize sample size and follow these recommendations for determining sample size:

- For populations with fewer than 100 individuals or units, it is often unnecessary to sample; surveying the entire population may be more practical.
- For populations around 500, sampling 50% of the population is advised.
- For populations around 1,500, a sample size of 20% is recommended.
- For populations exceeding approximately 5,000 units, the size of the population becomes less significant, and a sample size of 400 is generally sufficient.

Krejcie and Morgan (1970) developed a more scientific method of calculating the sample size. The research division of the National Education Association published a formula for determining sample size, which they used to develop a table of sample sizes (see appendix). The authors developed this table to simplify usage and support research efforts.

The formula employed to calculate the sample size is as follows:

$S = X2NP(1-P) / d2(N-1) + X2P(1-P)$

S = The required sample size

X2 = the table value of chi-square for 1 degree of freedom at the confidence level of 3.841.

N = the population size

P = population proportion assumed to be 0.50 which provides the maximum sample size

D = the degree of accuracy expressed. In this case, 0.05 was used.

Krejcie and Morgan (1970) state that when applying this formula, it will be noted that as the population grows, the sample size increases at a decreasing rate, levels off, and eventually stabilizes.

Sample size calculation for public sector:

$S = X2NP(1-P) / d2(N-1) + X2P(1-P)$

$S1= 3.841 \times 300 (1-50) / 0.50(2) (300-1) +3.841x50 (1-50)$

S1=5.82

Sample size calculation for contractors:

$S2= 3.841x100(1-50)/0.50(2) (100-1) + 3.841x50(1-50)$

S2=1.98

Sample size calculation for consultants:

$S3= 3.841x100(1-50)/0.50(2) (100-1) + 3.841x50(1-50)$

S3=1.98

4.3 VALIDITY AND RELIABILITY STATISTICS

The two most important aspects of precision are reliability and validity. Reliability, for example, refers to the consistency of a measure, ascertained through repeated trials. The robustness of a newly formulated construct is often validated through a reliability coefficient, with Cronbach's alpha being the prevalent statistical measure. An alpha coefficient threshold

of 0.60 or above is traditionally deemed 'acceptable' for nascent constructs, indicating a satisfactory level of internal consistency, and thus, reliability. This threshold serves as a guideline when interpreting the alpha scores derived from the items constituting the questionnaire within your study.

4.3.1. CRONBACH'S COEFFICIENT ALPHA TEST

Test for the internal reliability of the factor in each category were conducted by determining their Cronbach's coefficient α value.

Table 4. 3 : Cronbach's coefficient α value for all factor categories

	Section	N of Items	Cronbach's Alpha
S2	Challenges encountered by management at tendering	6	0.651
S3	Challenges experienced during tendering, on a scale	6	0.626
S4	The influence of these tender planning factors at the tendering stage on the delivery of construction projects in the KZN Department of Public Works	4	0.753
S5	Competency of professionals involved in the tender process at the KZN Department of Public Works on the delivery of construction projects	6	0.779
S6	Effectiveness of the tendering process during tendering at the KZN Department of Public Works in the delivery of projects	4	0.567
S7	Influence of political constraints and unethical practices during tendering at the KZN Department of Public Works on the delivery of construction projects	4	0.895
S8	The influence of corruption constraints on an effective tendering system for the delivery of construction projects in the KZN Department of Public Works	7	0.888
S9	Benefits of an automated tendering system for the delivery of construction projects in the KZN Department of Public Works	9	0.912
All items are included		46	0.950

The Cronbach's alpha scores for the various sections of the questionnaire reflect varying degrees of internal consistency. Sections S2 and S3, covering challenges encountered by management and experienced during tendering, demonstrate acceptable reliability with alphas of 0.651 and 0.626, respectively. Higher reliability is observed in sections S4 and S5, which deal with the influence of planning factors and professional competency, yielding alpha values of 0.753 and 0.779. Section S6, assessing the effectiveness of the tendering process, falls slightly below the acceptable threshold with an alpha of 0.567. In contrast, sections S7 and S8, relating to political and corruption constraints, exhibit strong reliability with scores of 0.895 and 0.888. The highest reliability is seen in Section S9, which evaluates the benefits of automation, with an alpha of 0.912. Overall, when all items are considered together, the instrument shows excellent reliability, as indicated by a Cronbach's alpha of 0.950, suggesting

the questionnaire is a highly reliable tool for assessing the constructs of interest in the context of the KwaZulu-Natal Department of Public Works.

4.4 RESULTS FOR FACTOR ANALYSIS

Factor analysis is a statistical method used to explore the underlying relationships between measured variables. It is often employed to identify clusters of variables, known as factors, which tend to co-vary with each other, indicating that they may be measuring underlying latent constructs. This technique is instrumental in reducing the dimensionality of data, enhancing the interpretability of complex constructs, and assisting in the development and refinement of theoretical models. Factor analysis is a pivotal step in scale development, helping to ascertain the validity and reliability of the measures.

A summarized table (4.3) precedes the matrix table that reflects the results of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. The table below presents the **KMO and Bartlett's tests**, which assess the data's suitability for structure detection. The **Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy** is a statistic that reflects the proportion of variance in the variables that may be attributed to underlying causes. High KMO values (close to 1.0) typically suggest that factor analysis is appropriate for the data, whereas values below 0.50 imply that factor analysis might not yield useful results.

Bartlett's test of sphericity examines the hypothesis that the correlation matrix is an identity matrix, meaning the variables are irrelevant and thus inappropriate for structure detection. A significance level below 0.05 means that factor analysis could be beneficial for the data.

Factor analysis was conducted exclusively on the Likert scale items, with specific elements further separated into more specific components as detailed in the rotated component matrix below.

Table 4. 4 : Summary of factor analysis conducted for category analysis.

KMO and Bartlett's Test

	Section	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	Bartlett's Test of Sphericity		
			Approx. Chi-Square	df	Sig.
S2	Challenges encountered by management at tendering	0.578	103.342	15	< 0.001
S3	Challenges experienced during tendering, on a scale	0.649	118.953	15	< 0.001
S4	The influence of these tender planning factors at the tendering stage on the delivery of construction projects in the KZN Department of Public Works	0.738	175.575	6	< 0.001
S5	Competency of professionals involved in the tender process at the KZN Department of Public Works on the delivery of construction projects	0.678	211.192	15	< 0.001
S6	Effectiveness of the tendering process during tendering at the KZN Department of Public Works in the delivery of projects	0.567	46.557	6	< 0.001
S7	Influence of political constraints and unethical practices during tendering at the KZN Department of Public Works on the delivery of construction projects	0.838	213.543	6	< 0.001
S8	The influence of corruption constraints against effective tendering systems for the delivery of construction projects in the KZN Department of Public Works	0.824	295.274	21	< 0.001
S9	Benefits of automated tendering systems for the delivery of construction projects in the KZN Department of Public Works	0.879	563.353	36	< 0.001

The requirements for factor analysis were all met. In other words, the Bartlett's Test of Sphericity sig. value needs to be beneath 0.05, and the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value must be more than 0.500.

Table 4.5.(a) :Challenges of tendering not project based

Rotated Component Matrix

S2	Component	
	1	2
Poor tender planning	0.541	0.477
Competency of professional teams	0.228	0.713
Effectiveness of tender the process	0.171	0.700
Corruption constraints militating against effective tendering system	0.858	0.060
Political constraints and unethical practices	0.899	0.048
Benefits of automating processes	-0.133	0.681
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

Table 4. 5 (b) :Challenges of tendering project based

S3	Component	
	1	2
Poor tender planning	0.475	0.496
Competency of professional teams	0.329	0.717
Effectiveness of the tender	0.682	0.165
Corruption constraints militating against effective tendering systems	0.819	0.005
Political constraints and unethical practices	0.812	0.018
Benefits of automating processes	-0.245	0.805

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Table 4. 5 (C): Poor tender planning

S4	Component
	1
Value of tendering processes	0.929
Type of tendering	0.900
Strategic significance to the tendering	0.083
The nature of tender	0.940

Extraction Method: Principal Component Analysis.

a. 1 component extracted.

Table 4.5 (d): Competency of professional team

S5	Component	
	1	2
Lack of supply chain team training	0.427	0.621
Unethical conduct	0.677	0.181
Tendering codes	-0.107	0.867
Ineffective communication	0.863	-0.005
Ineffective tendering co-ordination	0.855	0.229
Information sharing	0.881	-0.065

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Table 4.5 (e): Effectiveness of tendering

S6	Component	
	1	2
Time	0.877	-0.001
Cost	0.811	0.219
Safety	0.043	0.850
Quality	0.155	0.801

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Table 4.5 (f): Corruption constraints militating against tendering systems

S7	Component
	1
Money laundering	0.856
Conflict of interest	0.868
Corruption practices	0.880
Bribery	0.894
Extraction Method: Principal Component Analysis.	
1 component extracted.	

Table 4.5 (g): Political constraints and unethical practices

S8	Component	
	1	2
Nature of bid	0.834	0.213
Bids Vector	0.166	0.830
Bids divisible	0.163	0.852
Bundle of bids allowed	0.815	0.324
Reserved prices	0.874	0.080
Number of bid evaluation stages	0.885	0.214
Pre-bid meeting	0.916	0.109

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Table 4.5 (h): Benefits of automating

S9	Component	
	1	2
Cost reduction	0.174	0.820
Competitiveness enhancement by providing transparency	0.555	0.565
Equality	0.250	0.805
Proportionality	0.290	0.757
Performance	0.831	0.202
Efficiency	0.897	0.126
Reduction in the use of paper	0.802	0.422
Reduction in the cost of tendering	0.601	0.490
Reduced corruption	0.722	0.466
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

The items in sections S4 and S7 aligned precisely with a single factor, indicating that these sections accurately assessed what they were intended to measure. In contrast, the variables in the remaining sections were divided across two factors (sub-themes), suggesting that respondents perceived different patterns within these sections. The divisions are color-coded within the sections. Common factors are the highest loadings per component. Suggested names for the sub-themes are as follows:

S2:

- Component 1: "Tender Process Inefficiencies" (highlighted by the items 'Poor tender planning' and 'Corruption constraints militating against effective tendering systems')
- Component 2: "Professional Capability and Process Outcomes" (emphasized by 'Competency of professional teams' and 'Effectiveness of tender process')

S3:

- Component 1: "Tender Planning and Ethical Constraints"
- Component 2: "Professional Competence and Automation Advantages"

S5:

- Component 1: "Tender Operational Challenges" (with items like 'Ineffective communication' and 'Ineffective tendering co-ordination')
- Component 2: "Supply Chain Proficiency" (indicated by 'Lack of supply chain team training' and 'Tendering codes')

S6:

- Component 1: "Project Delivery Efficiency" (captured by 'Time' and 'Cost')
- Component 2: "Quality and Safety Standards" (highlighted by 'Safety' and 'Quality')

S8:

- Component 1: "Tender Procedure Complexity" (items such as 'Nature of bid' and 'Bundle of bids allowed')
- Component 2: "Evaluation and Selection Criteria" (with 'Bids Vector' and 'Bids divisible')

S9:

- Component 1: "Operational Efficiency" (encompassing 'Performance' and 'Efficiency')
- Component 2: "Economic and Ethical Benefits" (including 'Cost reduction' and 'Reduced corruption')

These sub-themes are used in the trend analysis within the sections.

4.5 DEMOGRAPHIC DATA OF RESPONDENTS

This section enables the stratification of data according to various demographic variables, such as age, gender, educational background, and professional experience. Such stratification is instrumental in ensuring that the interpretation of the subsequent sections is nuanced and considers demographic influences on the responses. It is the intent of this introductory section to set the stage for a comprehensive analysis, establishing a contextual framework for the insights derived from the more thematic aspects of the questionnaire.

Table 4.6: District of Employment

	Frequency	Percent
Ethekwini	32	31.1
Ugu	17	16.5
Harry Gwala	12	11.7
Umgungundlovu	15	14.6
Zululand	5	4.9
Mkhanyakude	5	4.9
King Cetshwayo	8	7.8
Umzinyathi	5	4.9
Amajuba	4	3.9
Total	103	100.0

The regional breakdown of respondents is as follows: eThekwini had the highest participation, at 31.1%, indicating a strong engagement from this area in the construction tendering process. Other regions, such as Ugu and Umgungundlovu, also showed notable representation, with 16.5% and 14.6%, respectively. The data suggests significant regional disparities in participation rates, which is statistically supported by a goodness of fit test result of $p < 0.001$. This finding highlights the geographical diversity of the sample and may reflect the varying levels of construction activity or interest in tender processes across the regions.

4.5.1 Sector

Figure 4.1 indicates the types of construction projects of the respondents. The majority of respondents belong to the new project (42.7%) of the total sample.

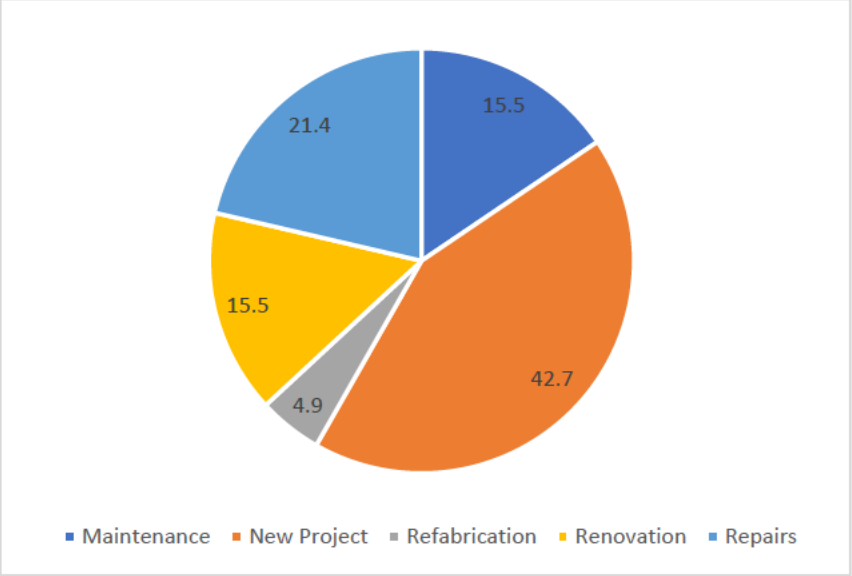


Figure 4. 1: Type of Construction Project

The distribution of types of construction projects indicates that 'New Project' is the most common type, involving 42.7% of the respondents. 'Repairs' and 'Maintenance' also represent significant portions, with 21.4% and 15.5%, respectively. 'Renovation' matches 'Maintenance' at 15.5%, while 'Refabrication' is least common at 4.9%. The statistical significance ($p < 0.001$) suggests a meaningful differentiation in the types of construction projects undertaken by the respondents.

Table 4.7: Organizational Tenure in Construction Tendering

N	Minimum	Maximum	Mean	Std. Deviation
103	1	29	18.3	8.7

Organizations reported a mean of 18.3 years of involvement in construction tendering, suggesting a sample with considerable experience in the field, though with a diverse range of tenure as indicated by the standard deviation of 8.7 years.

Table 4.8: Gender

	Frequency	Percent
Female	38	36.9
Male	65	63.1
Total	103	100.0

Gender distribution is skewed towards male respondents, who make up 63.1% of the sample, compared to 36.9% of female respondents, a disparity that is statistically significant ($p = 0.008$), reflecting the gender dynamics within the construction industry.

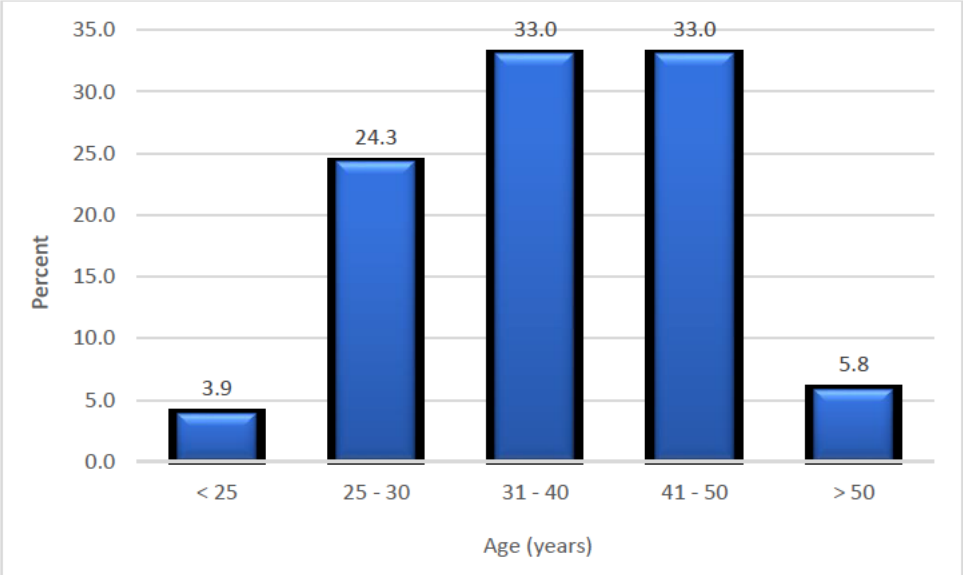


Figure 4. 2: Age Distribution

The age distribution among respondents reveals a concentration in the 31–50 age range, each accounting for 33.0% of the participants. Those aged 25–30 constitute 24.3%, while respondents below 25 and above 50 are under-represented, at 3.9% and 5.8%, respectively. This suggests a workforce with a significant proportion in the mid-career stage, which may correlate with a higher level of experience in the industry ($p < 0.001$).

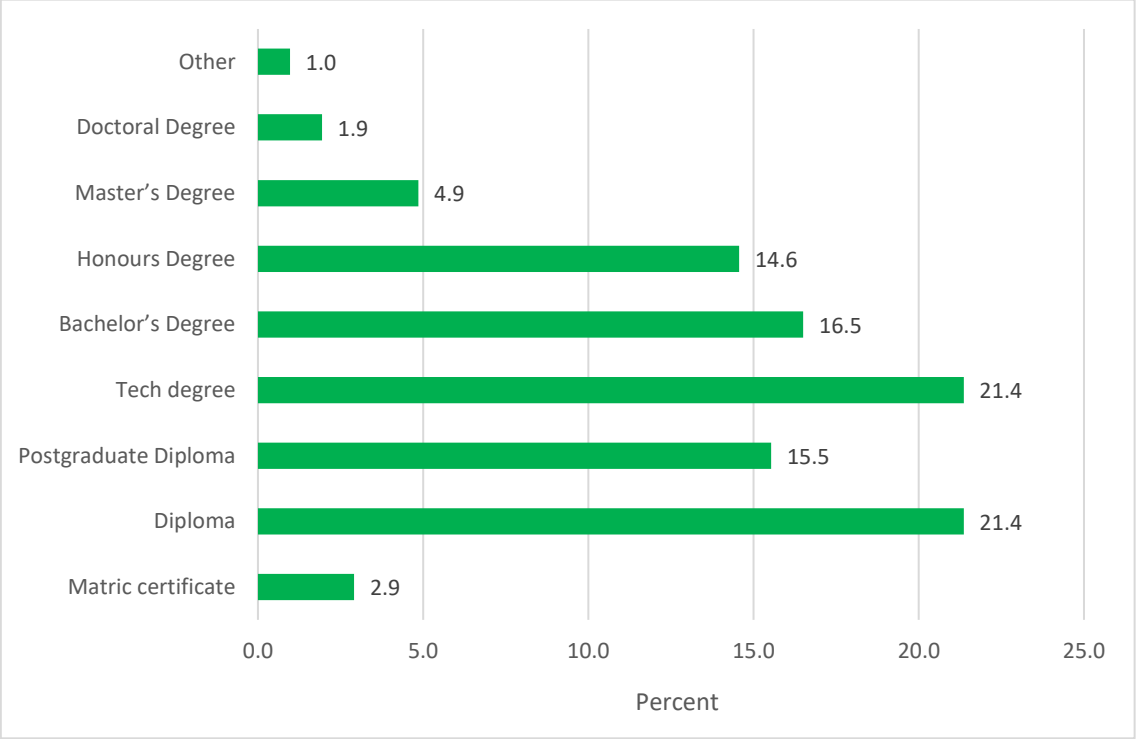


Figure 4. 3 :Highest Formal Qualification

The educational qualifications of the respondents showcase a diverse array of academic achievements. The majority hold either a diploma or a technical degree, each accounting for 21.4% of the participants. This is closely followed by those with bachelor's degrees at 16.5% and honours degrees at 14.6%. Postgraduate diplomas, master's degrees, and doctoral degrees are less common, indicating a workforce with a strong foundation of tertiary education, yet fewer have pursued advanced postgraduate studies. This diversity in educational backgrounds reflects a range of expertise within the construction tendering sector ($p < 0.001$).

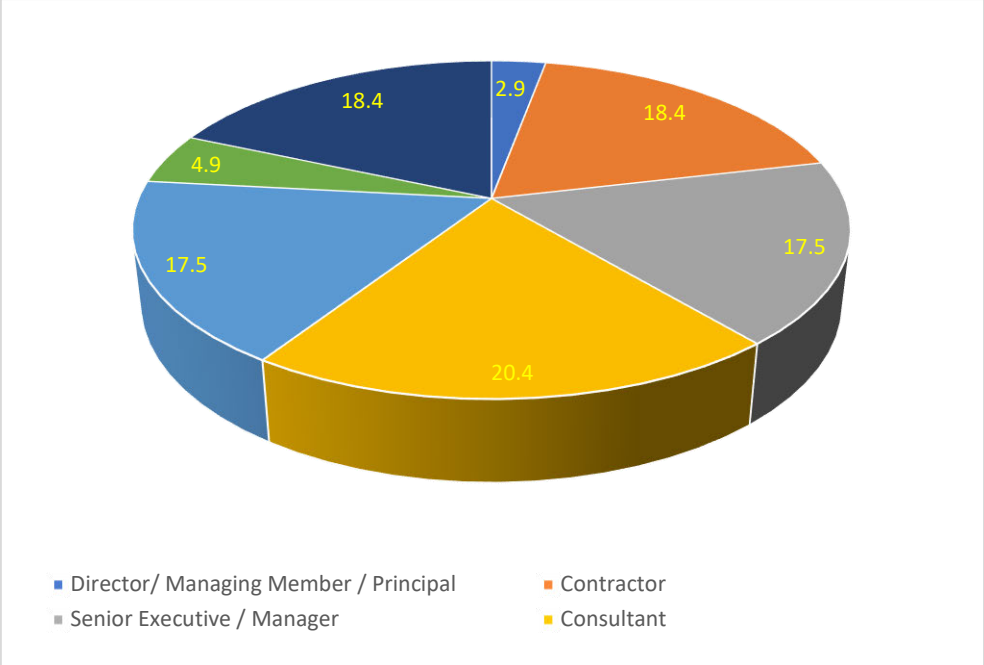


Figure 4. 4: Position within the Organization

The roles within the respondent group are diverse (p = 0.001), with the largest group being consultants (20.4%), followed by contractors (18.4%), and an equal representation of senior executives and supply chain managers (17.5% each). The categories of Director/Managing Member and Private Developers are under-represented, indicating a broad spread of participants across various levels and functions in the industry. This suggests that the insights gathered will reflect a wide spectrum of perspectives within the construction tendering process.

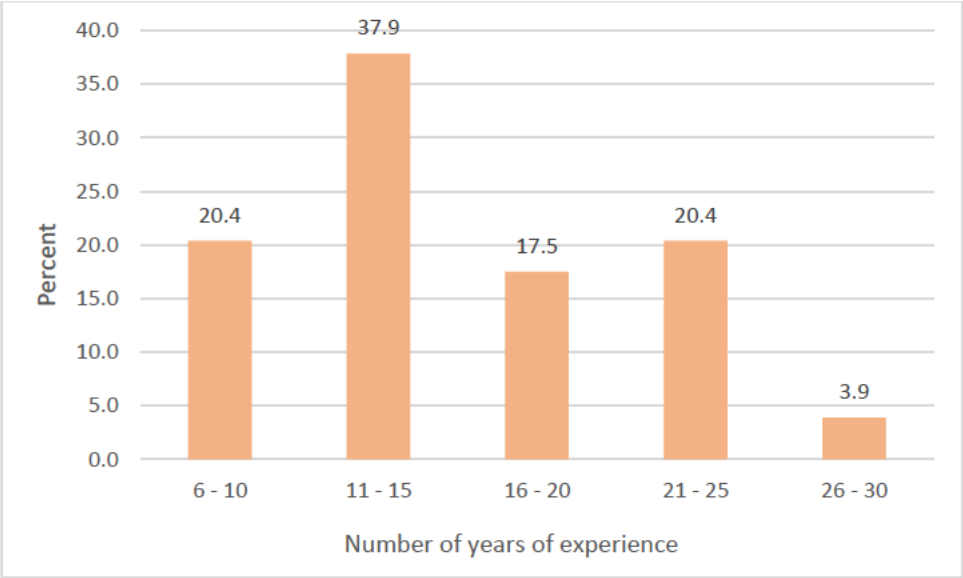


Figure 4. 5: Experience in Building Construction Tendering

The distribution of actual experience in building construction tendering shows the largest segment of respondents with 11–15 years of experience (37.9%), followed by those with 6–10 and 21–25 years (each 20.4%). Fewer respondents have 16–20 years (17.5%) or 26–30 years of experience (3.9%). This variance in experience is statistically significant ($p < 0.001$), indicating a seasoned pool of professionals with a broad range of experience.

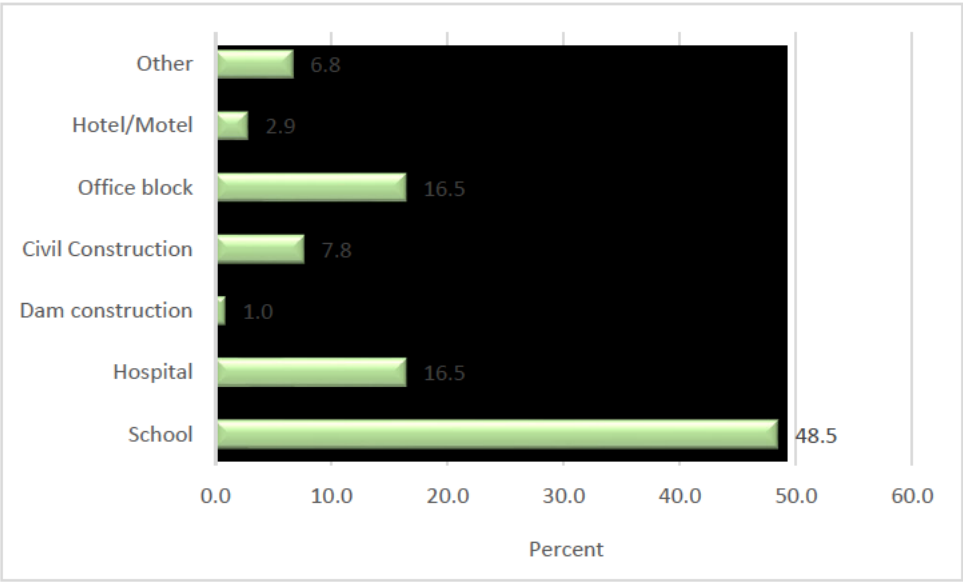


Figure 4. 6: Type of Facility Involved in Construction Tendering

The data indicates that schools are the most common type of facility involved in construction tendering, with 48.5% of respondents having experience in this area. Hospitals and office blocks are also significant, each accounting for 16.5%. Other types of construction, such as civil construction and hotels or motels, are less frequent, and dam construction is notably rare, with only 1% involvement. The variety of types of facilities points to a diverse range of construction projects represented by the respondents ($p < 0.001$).

Table 4.9: Number of Floors in Constructed Facilities

Number of Floors	Frequency	Percent
1	39	37.9
2	36	35.0
3 - 4	27	26.2
≥ 5	1	1.0
Total	103	100.0

The majority of respondents manage buildings with fewer floors, with 37.9% managing 1-floor buildings and 35.0% managing 2-floor buildings. High-rise buildings with 5 or more floors are less common in the responses (1.0%), showing a significant difference in the types of projects managed by respondents ($p < 0.001$). This could indicate a prevalence of smaller-scale projects within the regions represented by the sample.

4.6 ANALYSIS OF MAIN QUESTIONS IN FIRST QUESTIONNAIRE

The upcoming section examines the response patterns for each variable in each section. Initially, the results are displayed using aggregated percentages (and averages) for the variables in each section. Following this, the results are analysed in greater detail based on the significance of the statements.

4.6.1 GENERAL CHALLENGES NOT SPECIFYING PROJECTS

Table 4.8 presents the results of the survey investigating the challenges encountered by management during the tendering process within the KwaZulu-Natal Department of Public

Works. The ratings are on a scale of 1 to 5, where 1 means 'minor' and 5 means 'major' challenge. The table expresses the responses as percentages of the total responses. The table also provides the mean score, standard deviation, weighted mean, and rank of each challenge based on the weighted mean.

Table 4.10: Challenges in tendering in project delay in KZN DPW

	Factor	Response (%)							Mean Score	Standard Deviation	Weighted Mean	Rank	Binomial Test p-value (cut off = 3.0)
		Unsure	Does not apply	Minor.....Major									
				1.00	2.00	3.00	4.00	5.00					
S2.4	Corruption constraints militating against effective tendering systems	0.0	0.0	0.0	9.7	11.7	38.8	39.8	4.1	1.0	4.09	1	< 0.001
S2.5	Political constraints and unethical practices	0.0	0.0	2.9	7.8	7.8	43.7	37.9	4.1	1.0	4.06	2	< 0.001
S2.1	Poor tender planning	0.0	0.0	3.9	6.8	45.6	35.9	7.8	3.4	0.9	3.37	3	0.237
S2.2	Competency of professional teams	1.0	0.0	2.9	6.8	48.5	37.9	2.9	3.3	0.8	3.31	4	0.092
S2.3	Effectiveness of tender the process	3.0	0.0	3.0	4.0	53.5	32.7	4.0	3.3	0.8	3.31	5	0.020
S2.6	Benefits of automating processes	13.6	7.8	15.5	17.5	18.4	20.4	6.8	2.8	1.3	2.85	6	0.007

Table 4.10 above indicates that the prevalence of corruption and political challenges were the top two factors, 'corruption constraints' (S2.4) and 'political constraints and unethical practices' (S2.5), both of which scored the highest mean and weighted mean, signifying they are perceived as the most significant challenges. The fact that no respondents were unsure or felt that these issues did not apply indicates a universal agreement on their importance. This may reflect a common perception that corruption and political interference are major impediments to effective tendering.

'Poor tender planning' (S2.1) and 'competency of professional teams' (S2.2) were ranked third and fourth, respectively, indicating concerns over these areas. These factors have a lower mean score compared to the top two challenges but are still seen as significant, suggesting that respondents recognize that internal processes and the skills of the teams are critical areas for improvement.

'Effectiveness of the tender process' (S2.3) was ranked fifth, with a mean score identical to 'competency of professional teams' but with a slightly higher percentage of respondents rating it as a major issue. This indicates that, while it is a recognized challenge, it is not perceived to be as critical as corruption or political issues.

The 'benefits of automating processes' (S2.6) was ranked sixth and received the lowest weighted mean. This might suggest that there was either a low-level understanding of the benefits automation could bring or there was scepticism about its effectiveness. It is notable that this is the only category where a significant percentage of respondents were unsure or felt it did not apply, which could indicate a lack of familiarity with or confidence in automated processes.

Statistically, the standard deviations for most factors were relatively low, suggesting a narrow distribution of responses and degree of consensus among the respondents. However, the 'benefits of automating processes' has a higher standard deviation, showing more variability in the responses, again possibly due to varying levels of understanding or opinion about this issue. The spread of p-values reflects the complexity of issues within the tendering system. While certain problems are universally acknowledged (like corruption) and are highly significant, others are recognized but to varying degrees. This implies a multifaceted challenge in addressing these issues; tackling the most statistically significant problems might yield the

most immediate benefits, but a comprehensive approach addressing all concerns would be beneficial in the long term.

Possible reasons for the above analysis:

i. The high ranking of corruption and political challenges may be indicative of a widely recognized issue within the region or sector that affects many public works departments globally.

ii. The emphasis placed on planning and competency suggests an understanding that better preparation and skilled professionals can significantly improve the tendering process.

iii. The recognition of the tender process's effectiveness implies a desire for more streamlined and efficient tendering procedures.

iv. The lower priority given to the benefits of automation may be due to a lack of exposure to or understanding of how technology can be leveraged to improve tender processes.

v. There might also be concerns about the implementation costs, resistance to change, or doubts about the feasibility of automation within the current system.

vi. Each of these insights can be valuable for informing decisions about where to focus efforts to improve the tendering system in the KwaZulu-Natal Department of Public Works.

4.6.2 TENDERING CHALLENGES PROJECT BASED TOP OF FORM

This section rates the influence of various challenges experienced during the tendering process on a scale from 1 (minor) to 5 (major).

Table:4.11: Influence in tendering in project in project delivery in KZN DPW

	Factor	Response (%)							Mean Score	Standard Deviation	Weighted Mean	Rank	Binomial Test p-value (cut off = 3.0)
		Unsure	Does not apply	Minor.....Major									
				1.00	2.00	3.00	4.00	5.00					
S3.5	Political constraints and unethical practices	0.0	0.0	0.0	9.7	17.5	26.2	46.6	4.1	1.0	4.10	1	< 0.001
S3.4	Corruption constraints militating against effective tendering systems	0.0	0.0	1.0	8.7	12.6	39.8	37.9	4.0	1.0	4.05	2	< 0.001
S3.3	Effectiveness of tender the process	0.0	0.0	3.9	11.7	45.6	36.9	1.9	3.2	0.8	3.21	3	0.030
S3.1	Poor tender planning	0.0	0.0	2.9	14.6	53.4	28.2	1.0	3.1	0.8	3.10	4	< 0.001
S3.2	Competency of professional teams	0.0	0.0	1.9	13.6	58.3	25.2	1.0	3.1	0.7	3.10	5	< 0.001
S3.6	Benefits of automating processes	0.0	0.0	22.3	33.0	28.2	11.7	4.9	2.4	1.1	2.44	6	< 0.001

Table 4.11 presents the respondents' rating on the influence of tendering on the projects. The challenges 'political constraints and unethical practices' (S3.5) and 'corruption constraints militating against effective tendering systems' (S3.4) were rated the highest, both in mean and weighted mean scores. This indicates that they were perceived as the most significant challenges in the tendering process. The unanimous agreement (with no respondents unsure or feeling these issues do not apply) suggests a widespread recognition of these issues as major impediments to effective tendering.

The challenges 'poor tender planning' (S3.1) and 'competency of professional teams' (S3.2), though ranked slightly lower, still received significant ratings. This indicates that these areas are seen as considerable challenges, albeit not as critical as political and corruption issues. These ratings suggest an awareness among respondents that improving internal processes and enhancing team competency are crucial for the efficiency of the tendering process.

The challenge 'effectiveness of tender process' (S3.3) was rated as the third most significant challenge. The relatively high rating implies that while it was recognized as a challenge, it was not perceived to be as influential in hindering the tendering process as corruption or political issues. This rating reflects an acknowledgment of the need for more streamlined and efficient tendering procedures.

The challenge 'benefits of automating processes' (S3.6), received the lowest weighted mean, is rated as the least significant challenge. This might suggest either a lower awareness of the potential benefits that automation could bring or scepticism about its effectiveness in the current tendering system. The fact that this is the only category with a significant percentage of respondents unsure or feeling it does not apply, which could indicate a lack of familiarity with or confidence in automated processes.

All challenges have p-values of < 0.001, indicating that the ratings were statistically significant and not due to random variation. This suggests a strong agreement among respondents regarding the influence of these challenges in the tendering process.

In conclusion, the ratings reflect a clear prioritization of challenges, with political and corruption issues being perceived as the most influential, followed by concerns over planning, competency, and the effectiveness of the tender process. The least influential challenge is the benefits of automating processes, indicating potential areas for increased awareness or exploration. This prioritization can guide efforts to address these challenges in the KwaZulu-Natal Department of Public Works, focusing on the most impactful areas first.

4.6.3 TENDER PLANNING

This question looks at the influence of these tender planning factors at the tendering stage on the delivery of construction projects in the KZN DPW.

Table:4.12: Influence of these tender planning factors at the tendering stage on the delivery of construction projects in the KZN Department of Public Works

	Factor	Response (%)							Mean Score	Standard Deviation	Weighted Mean	Rank	Binomial Test p-value (cut off = 3.0)
		Unsure	Does not apply	Minor.....Major									
				1.00	2.00	3.00	4.00	5.00					
S4.4	The nature of tender	2.9	1.0	3.9	13.6	8.7	28.2	41.7	3.9	1.2	3.90	1	< 0.001
S4.2	Type of tendering	1.0	1.0	2.9	11.7	17.5	39.8	26.2	3.8	1.1	3.75	2	0.001
S4.1	Value of tendering processes	1.9	1.9	5.8	9.7	16.5	35.9	28.2	3.7	1.2	3.71	3	0.001
S4.3	Strategic significance to the tendering	8.7	3.9	6.8	28.2	31.1	17.5	3.9	2.8	1.0	2.83	4	< 0.001

Table 4.12 Analysis of the responses related to the influence of tender planning factors at the tendering stage on the delivery of construction projects in the KZN Department of Public Works revealed the following patterns: The most influential factors were 'the nature of tender' (S4.4) and 'type of tendering' (S4.2). Both factors scored highly in the mean and the weighted mean, highlighting their perceived critical impact on project delivery. The strong consensus on their importance, indicated by low p-values (< 0.001 and 0.001, respectively), suggests that the characteristics of the tender and the tendering approach significantly shape the outcomes of construction projects.

The 'value of tendering processes' (S4.1) was also seen as a significant factor, though slightly less impactful than the nature and type of tenders. Its mean score of 3.7 and a weighted mean of 3.71, coupled with a p-value of 0.001, indicate that the monetary aspects and the valuation processes of tendering are critical in determining the success of construction projects. This reflects an understanding that the financial framework, which evaluates, and awards tenders plays a key role in project delivery.

'Strategic significance' to the tendering' (S4.3) was ranked fourth. Despite a lower mean score of 2.8, the factor was still considered influential, as indicated by its weighted mean of 2.83 and a significant p-value of < 0.001. This suggests that the strategic importance attached to different tenders influences how they are managed and, subsequently, their impact on project success.

In summary, the findings underscore the critical role of the nature and type of tenders in shaping the outcomes of construction projects in the KZN Department of Public Works. Additionally, the financial valuation processes and the strategic significance of tenders were also seen as influential, albeit to a lesser extent. These insights highlight the multifaceted nature of tender planning and its direct impact on the effective delivery of construction projects. Addressing these factors could lead to more successful project outcomes, indicating potential areas for strategic focus and improvement.

4.6.4 COMPETENCY OF PROFESSIONALS

In this part of the study, the competency of professionals involved in the tender process at the KZN Department of Public Works, in terms of their impact on the delivery of construction projects, is examined.

The results are shown below.

Table:4.13 Influence of competency of professional in the tender process at the KZN Department of Public Works on the delivery of construction project

	Factor	Response (%)							Mean Score	Standard Deviation	Weighted Mean	Rank	Binomial Test p-value (cut off = 3.0)
		Unsure	Does not apply	Minor.....Major									
				1.00	2.00	3.00	4.00	5.00					
S5.6	Information sharing	1.0	0.0	2.9	5.8	21.4	48.5	20.4	3.8	0.9	3.78	1	< 0.001
S5.4	Ineffective communication	0.0	0.0	4.9	6.8	20.4	45.6	22.3	3.7	1.0	3.74	2	< 0.001
S5.2	Unethical conduct	1.0	0.0	3.9	8.7	23.3	40.8	22.3	3.7	1.0	3.69	3	0.007
S5.5	Ineffective tendering co-ordination	0.0	0.0	3.9	9.7	21.4	51.5	13.6	3.6	1.0	3.61	4	0.003
S5.1	Lack of supply chain team training	1.9	0.0	5.8	22.3	49.5	20.4	0.0	2.9	0.8	2.86	5	< 0.001
S5.3	Tendering codes	11.7	4.9	2.9	43.7	28.2	8.7	0.0	2.5	0.7	2.59	6	< 0.001

Table 4.13 illustrates the ratings provided by the respondents regarding the influence of the competency of professionals on tendering processes within the KZN Department of Public Works. 'Information sharing' emerged as the top-rated factor, as evidenced by both its highest mean and weighted mean scores, emphasizing its critical role in successful project delivery. The overwhelming majority of respondents (48.5%) rated it as a major influence underlines the significance of effective communication and data exchange in the tender process. The statistical significance (p-value < 0.001) confirms the strong consensus on its importance.

The second most significant factor was 'ineffective communication', highlighted by its high mean score and a substantial percentage (45.6%) of respondents who considered it a major issue. This indicates that communication barriers or inefficiencies are perceived as a significant hindrance to the effectiveness of the tender process. The strong statistical backing (p-value < 0.001) reinforces its perceived impact.

'Unethical conduct' was identified as the third most influential factor. Its considerable mean score and weighted mean, along with 40.8% of responses rated it as a major issue, signifying concerns about ethical practices in tendering. The significance of this factor (p-value 0.007) suggests that ethical integrity is a key consideration in the successful delivery of construction projects.

Ranked fourth, 'ineffective tendering co-ordination' reflected the importance of well-orchestrated co-ordination in the tendering process. Over half of the respondents (51.5%) viewed it as a major issue, emphasizing the need for efficient management and co-ordination. Its significant impact is further underscored by a p-value of 0.003.

'Lack of supply chain team training' was the fifth-ranked factor. While it has a lower mean score compared to others, a high percentage of respondents (49.5%) rated it as a major challenge, indicating a significant concern over the skill and knowledge levels of supply chain teams. The statistical significance (p-value < 0.001) suggests a consensus on the need for enhanced training and development.

The factor 'tendering codes' was ranked sixth, indicating it was perceived as the least impactful among the factors assessed. However, its statistical significance (p-value < 0.001) suggests that, while it may be less influential, it is still a relevant aspect of the tender process.

In summary, these insights highlight the critical importance of information sharing, effective communication, ethical conduct, and co-ordination in tender processes for successful project

delivery in the KZN Department of Public Works. Additionally, the significance of addressing training needs in supply chain teams and adhering to tendering codes, although perceived as less impactful, is recognized as important factors in the overall tendering landscape. This analysis underscores the multifaceted nature of competency in the tendering process and its direct influence on the outcomes of construction projects.

4.6.5 EFFECTIVENESS OF TENDERING PROCESS

This question looks at the effectiveness of the tendering process during tendering at the KZN Department of Public Works in the delivery of projects.

Table: 4.14: The effectiveness of the tendering process during tendering at the KZN Department of Public Works in the delivery of projects

	Factor	Response (%)							Mean Score	Standard Deviation	Weighted Mean	Rank	Binomial Test p-value (cut off = 3.0)
		Unsure	Does not apply	Minor.....Major									
				1.00	2.00	3.00	4.00	5.00					
S6.1	Time	1.0	0.0	0.0	17.5	31.1	44.7	5.8	3.4	0.8	3.39	1	0.921
S6.2	Cost	0.0	0.0	0.0	12.6	51.5	34.0	1.9	3.3	0.7	3.25	2	0.006
S6.4	Quality	1.0	0.0	6.8	14.6	56.3	19.4	1.9	3.0	0.8	2.95	3	< 0.001
S6.3	Safety	1.0	1.0	11.7	44.7	30.1	11.7	0.0	2.4	0.9	2.44	4	< 0.001

Table 4.14 presents the rating of the respondents on the effectiveness of tendering processes at the KZN DPW. Time' is identified as the most influential factor, with the highest rank in terms of its impact on project delivery. The mean score is 3.4 and the weighted mean is 3.39. A significant 44.7% of respondents rated it as a major factor, highlighting the critical role of timely execution in the tendering process.

However, the standard deviation of 0.8 indicates some variation in responses.

Notably, the p-value of 0.921 is an outlier compared to other factors, suggesting that while time is considered important, there may be less consensus on its impact than other factors.

Cost' is ranked second, indicating its perceived importance in project success. It has a mean score of 3.3 and a weighted mean of 3.25, with 51.5% of responses rating it as a major influence. This underscores the emphasis on cost management within the tendering process.

The lower standard deviation of 0.7 points to a higher level of agreement among respondents.

The p-value of 0.006 suggests a significant consensus on the impact of cost management.

Ranked third, 'Quality' is recognized as a crucial factor in the tendering process.

It achieves a mean score of 3.0 and a weighted mean of 2.95, with 56.3% considering it a major factor, reflecting the focus on maintaining high-quality standards in project deliverables.

The standard deviation of 0.8 suggests some variability in how its impact is perceived.

The highly significant p-value of < 0.001 indicates a strong agreement on the importance of quality.

Safety' is the fourth-ranked factor, highlighting its relevance in project delivery. With a mean score of 2.4 and a weighted mean of 2.44, it is considered important but less so than time, cost, and quality. The higher standard deviation of 0.9 indicates more varied opinions on its impact. Despite its lower ranking, the p-value of < 0.001 shows a significant consensus on the role of safety in the tendering process.

In summary, these findings highlight the multifaceted nature of the tendering process at the KZN Department of Public Works, with time management, cost considerations, quality focus, and safety concerns all playing significant roles in the successful delivery of projects. The varying degrees of consensus on each factor's impact, as reflected in their p-values and standard

deviations, underscore the complexity of balancing these elements to achieve effective project outcomes.

4.6.6 POLITICAL CONSTRAINTS AND UNETHICAL PRACTICES

This section looks at how respondents have rated the influence of political constraints and unethical practices during tendering at the KZN Department of Public Works on the delivery of construction project.

Table:4.15: The influence of political constraints and unethical practices on tendering at the KZN Department of Public Works in the delivery of construction project

	Factor	Response (%)							Mean Score	Standard Deviation	Weighted Mean	Rank	Binomial Test p-value (cut off = 3.0)
		Unsure	Does not apply	Minor.....Major									
				1.00	2.00	3.00	4.00	5.00					
S7.2	Conflict of interest	1.9	0.0	1.0	9.7	15.5	19.4	52.4	4.1	1.1	4.13	1	< 0.001
S7.3	Corruption practices	1.0	0.0	1.0	6.8	17.5	26.2	47.6	4.1	1.0	4.13	2	< 0.001
S7.4	Bribery	4.9	0.0	1.0	11.7	24.3	18.4	39.8	3.9	1.1	3.84	3	0.033
S7.1	Money laundering	8.7	0.0	0.0	17.5	33.0	34.0	6.8	3.3	0.9	3.30	4	0.353

Table 4.16 presents the respondents' ratings on the influence of the political constraints and ethical practices on the tendering processes. Both 'conflict of interest' (S7.2) and 'corruption practices' (S7.3) were identified as the most significant challenges, with identical mean and weighted mean scores (4.1 and 4.13, respectively). This parity suggests that these issues were perceived equally as major impediments in the tendering process. The overwhelming majority rated these as major issues (52.4% for 'conflict of interest' and 47.6% for 'corruption practices') indicates a universal agreement on their detrimental impact. The extremely low p-values (< 0.001) for both factors confirm the statistical significance of this consensus.

'Bribery was ranked as the third-most significant challenge. Its mean score of 3.9 and weighted mean of 3.84 suggest it is considered a major issue, though slightly less so than 'conflict of interest' and 'corruption practices". The factor was rated as a major issue by 39.8% of respondents, highlighting it as a prevalent concern. The p-value of 0.033, while significant, was higher than the first two factors, indicating a somewhat lesser degree of consensus.

'Money laundering' was ranked fourth, with lower mean (3.3) and weighted mean (3.30) scores. This suggests it was seen as a significant challenge, but its impact was perceived as less critical compared to the other factors. 34.0% of respondents considered it a major issue, indicating awareness of its existence and influence on project delivery. The higher p-value of 0.353, compared to other factors, suggests less agreement among respondents regarding its impact on the tendering process.

In summary, these insights reflect a clear prioritization of challenges, with conflict of interest and corruption practices being perceived as the most influential on project delivery, followed by concerns over bribery and money laundering. The significant p-values for all factors, particularly conflict of interest and corruption practices, underscore the widespread recognition of these unethical practices as critical hindrances in the tendering process at the KZN Department of Public Works. Addressing these areas could lead to more transparent and effective project outcomes.

4.6.7 CORRUPTION CONSTRAIN.

This section considers the influence of corruption constraints against effective tendering systems for the delivery of construction projects in the KZN DPW.

Table:4.16: The influence of corruption constraints on effective tendering systems in the delivery of construction projects at the KZN Department of Public Works

	Factor	Response (%)							Mean Score	Standard Deviation	Weighted Mean
		Unsure	Does not apply	Minor.....Major							
				1.00	2.00	3.00	4.00	5.00			
S8.7	Pre-bid meeting	2.9	0.0	1.9	6.8	10.7	21.4	56.3	4.3	1.0	4.23
S8.6	Number of bid evaluation stage	1.9	0.0	1.0	8.7	13.6	26.2	48.5	4.1	1.0	4.13
S8.5	Reserved prices	2.9	1.0	1.9	7.8	15.5	19.4	51.5	4.2	1.1	4.11
S8.4	Bundle of bids allowed	1.0	1.9	1.0	10.7	13.6	47.6	24.3	3.9	1.0	3.83
S8.1	Nature of bid	3.9	1.0	4.9	11.7	14.6	32.0	32.0	3.8	1.2	3.75
S8.2	Bids Vector	27.2	1.0	2.9	23.3	34.0	8.7	2.9	2.8	0.9	2.85
S8.3	Bids divisible	23.3	3.9	1.9	34.0	24.3	9.7	2.9	2.7	0.9	2.78

Table 4.16 presents the respondents' rating on the influence of corruption on the tendering processes of the KZN DPW. The pre-bid meetings emerged as the most significant factor, with the highest mean score (4.3) and weighted mean (4.23). This indicates that the processes and discussions occurring in pre-bid meetings were seen as crucial in influencing the integrity and effectiveness of the tendering process. A significant 56.3% of respondents view it as a major issue, reflecting serious concerns about the potential for corruption in these early stages of tendering. The low p-value of < 0.001 highlights a strong consensus on its impact.

The 'number of bid evaluation stages' was ranked second, signifying its perceived impact on curbing corruption. The mean score of 4.1 and weighted mean of 4.13 indicate that respondents consider the structure and number of evaluation stages as pivotal to maintaining a fair tendering process. With 48.5% rating it as a major issue and a p-value of < 0.001, there is significant agreement on its importance in preventing corrupt practices.

'Reserved prices' was identified as the third-most influential factor. Its mean score of 4.2 and weighted mean of 4.11 suggest that transparency and fairness in setting reserved prices were critical to mitigating corruption. 51.5% of respondents rated the factor as a major issue, along with a p-value of < 0.001, underscoring significant concern about its role in the tendering process.

Ranked fourth, the 'bundle of bids allowed' indicated concerns about the possibility of bundling bids to manipulate outcomes. It has a mean score of 3.9 and a weighted mean of 3.83. 47.6% considered this factor a major issue, with a p-value of < 0.001, indicating substantial concern about maintaining tender integrity.

'Nature of bid' was ranked fifth, with a mean score of 3.8 and a weighted mean of 3.75. This reflects the belief that the inherent characteristics of bids can significantly influence the likelihood of corrupt practices. The factor's p-value of 0.001 suggests a strong but slightly lesser agreement on its impact compared to the top-ranked factors.

'Bids Vector' and 'Bids divisible' were ranked sixth and seventh respectively. Despite their perceived lack of influence compared to other factors, their significant p-values of less than 0.001 demonstrate their recognition in the tendering process.

In summary, these insights highlight a clear hierarchy of concerns related to corruption in the tendering process. Factors like pre-bid meetings, bid evaluation stages, and reserved prices were perceived as most critical in influencing the integrity of tenders. The significant p-values across all factors underscore the widespread recognition of these aspects as potential avenues for corruption, emphasizing the need for vigilance and transparent practices in all stages of the tendering process at the KZN Department of Public Works.

4.6.8 BENEFITS OF AUTOMATION TENDERING

This section looks at the benefits of automated tendering systems for the delivery of construction projects in the KZN DPW.

Table:4.17: The benefits of automated tendering systems for the delivery of construction projects in the KZN DPW

	Factor	Response (%)							Mean Score	Standard Deviation	Weighted Mean	Rank	Binomial Test p-value (cut off = 3.0)
		Unsure	Does not apply	Minor.....Major									
				1.00	2.00	3.00	4.00	5.00					
S9.9	Reduced corruption	1.0	0.0	0.0	4.9	14.6	21.4	58.3	4.3	0.9	4.33	1	< 0.001
S9.7	Reduction in the use of paper	0.0	0.0	0.0	6.8	17.5	15.5	60.2	4.3	1.0	4.29	2	< 0.001
S9.2	Competitiveness enhancement by providing transparency	0.0	0.0	0.0	3.9	16.5	33.0	46.6	4.2	0.9	4.22	3	< 0.001
S9.8	Reduction in cost of tendering	1.0	1.0	1.0	5.8	30.1	14.6	46.6	4.0	1.1	4.00	4	0.017
S9.6	Efficiency	0.0	0.0	1.9	7.8	15.5	39.8	35.0	4.0	1.0	3.98	5	< 0.001
S9.3	Equality	0.0	0.0	1.0	7.8	28.2	32.0	31.1	3.8	1.0	3.84	6	0.010
S9.1	Cost reduction	1.9	0.0	0.0	10.7	32.0	35.0	20.4	3.7	0.9	3.65	7	0.232
S9.5	Performance	1.0	0.0	4.9	9.7	28.2	38.8	17.5	3.5	1.0	3.54	8	0.198
S9.4	Proportionality	0.0	0.0	1.0	7.8	45.6	29.1	16.5	3.5	0.9	3.52	9	0.431

Table 4.17 presents the respondents' rating of the benefits of automation tendering at the KZN DPW. The respondents rated 'reduced corruption' as the most beneficial aspect of automation, with the highest mean score of 4.3 and weighted mean of 4.33. This indicates a strong belief that automation can significantly mitigate corrupt practices in the tendering process. A substantial 58.3% of respondents view it as a major benefit, highlighting the critical role of automation in enhancing the integrity of tendering. The p-value of < 0.001 underscores the widespread consensus on this benefit.

'Reduction in the use of paper' was the second most significant advantage, with a mean score and weighted mean of 4.3 and 4.29, respectively. This reflects an environmental and efficiency-driven perspective on automation. 60.2% rated it as a major benefit indicating a strong inclination towards sustainability and efficiency gains. The p-value of < 0.001 suggests a significant agreement among respondents.

'Competitiveness enhancement by providing transparency' was ranked third and viewed as a key advantage. Its mean score of 4.2 and weighted mean of 4.22 point to the belief that automation can make the tendering process more transparent and competitive. The factor being considered a major benefit by 46.6% of respondents and a p-value of < 0.001 highlights the importance placed on transparency in tendering.

Reduction in cost of tendering' and 'efficiency' were ranked fourth and fifth, with mean scores of 4.0 each and weighted means of 4.00 and 3.98, respectively. These factors emphasize cost-effectiveness and improve operational efficiency as key benefits of automation. The significant p-values (0.017 for cost reduction and < 0.001 for efficiency) demonstrate a strong belief in these advantages.

'Equality' was perceived as the sixth most beneficial aspect, with a mean score of 3.8 and a weighted mean of 3.84, suggesting that automation is seen as a tool to level the playing field in tendering. The p-value of 0.010 indicates a significant but less unanimous view compared to the top-ranked benefits.

'Cost reduction' and 'Performance' were ranked seventh and eighth. While seen as benefits, their lower rankings and p-values (0.232 and 0.198, respectively) suggest they are perceived as less impactful compared to other factors. Proportionality' is ranked ninth, indicating it is seen as the least impactful benefit of automation. Its mean score of 3.5 and p-value of 0.431 suggest it is a recognized but less emphasized aspect of the automated tendering process.

In summary, these insights highlight the perceived benefits of automating the tendering system, with a particular emphasis on reducing corruption, enhancing environmental sustainability, and improving transparency and competitiveness. The significant agreement on these benefits underscores the potential of automation to address key challenges in the tendering process at the KZN Department of Public Works.

4.7 ANALYSIS BY SUB-THEMES

The factor analysis results, when correlated with the response percentages and mean scores, indicate clear patterns in perceptions among the participants. For instance, high mean scores in S2 and S3 for 'corruption constraints' and 'political constraints' indicate these are perceived as significant impediments in the tendering process. Meanwhile, the lower mean scores for 'benefits of automating processes' in both sections suggest ambivalence or lower recognition of the benefits. In S5, 'information sharing' and 'ineffective communication' are key operational challenges, yet 'lack of supply chain team training' receives a lower mean score, hinting at possible gaps in training acknowledgment. The low mean score for 'safety' in S6 contrasts with the high scores for 'time' and 'cost', suggesting efficiency and financial concerns are prioritized over safety. Each factor's rank, based on the weighted mean, reflects its relative importance or impact as perceived by the survey participants.

4.7.1 KRUSKAL-WALLIS TESTS

The Kruskal-Wallis test is a non-parametric statistical method used to assess whether there are significant differences between two or more groups concerning an independent variable, with respect to a continuous or ordinal dependent variable. It extends the Mann-Whitney U test to accommodate multiple groups and is employed when the assumptions of one-way ANOVA, particularly concerning the normal distribution of residuals, are not satisfied. If you have results from a Kruskal-Wallis test, they can indicate whether the differences in median ranks among your groups are significant, typically with respect to the subthemes identified in your factor analysis.

The biographical variables were tested against all variables. The results are shown in the table 4.15.

As an example, the following is used to describe the result.

The null hypothesis claims that there is no difference in the means (distributions) for 'political constraints and unethical practices' and across all districts where the study was conducted.

The resulting p-value (p = 0.037) indicates that there is a significant difference.
To identify the specific differences, a pairwise comparison test table was investigated.

Table 4.18: Pairwise comparison

Pairwise Comparisons of In which district do you work?					
Sample 1-Sample 2	Test Statistic	Std. Error	d. Test Statis	Sig.	Adj. Sig.[a]
Mkhanyakude-Amajuba	-11,575	18,602	-0,622	0,534	1,000
Mkhanyakude-Ethekwini	24,528	13,335	1,839	0,066	1,000
Mkhanyakude-Harry Gwala	27,533	14,761	1,865	0,062	1,000
Mkhanyakude-Umgungundlovu	31,400	14,320	2,193	0,028	1,000
Mkhanyakude-King Cetshwayo	-35,950	15,809	-2,274	0,023	0,827
Mkhanyakude-Ugu	42,876	14,108	3,039	0,002	0,085
Mkhanyakude-Umzinyathi	-45,400	17,538	-2,589	0,010	0,347
Mkhanyakude-Zululand	46,900	17,538	2,674	0,007	0,270
Amajuba-Ethekwini	12,953	14,706	0,881	0,378	1,000
Amajuba-Harry Gwala	15,958	16,010	0,997	0,319	1,000
Amajuba-Umgungundlovu	19,825	15,605	1,270	0,204	1,000
Amajuba-King Cetshwayo	24,375	16,981	1,435	0,151	1,000
Amajuba-Ugu	31,301	15,410	2,031	0,042	1,000
Amajuba-Umzinyathi	33,825	18,602	1,818	0,069	1,000
Amajuba-Zululand	35,325	18,602	1,899	0,058	1,000
Ethekwini-Harry Gwala	-3,005	9,387	-0,320	0,749	1,000
Ethekwini-Umgungundlovu	-6,872	8,677	-0,792	0,428	1,000
Ethekwini-King Cetshwayo	-11,422	10,961	-1,042	0,297	1,000
Ethekwini-Ugu	-18,348	8,323	-2,205	0,027	0,989
Ethekwini-Umzinyathi	-20,872	13,335	-1,565	0,118	1,000
Ethekwini-Zululand	-22,372	13,335	-1,678	0,093	1,000
Harry Gwala-Umgungundlovu	-3,867	10,740	-0,360	0,719	1,000
Harry Gwala-King Cetshwayo	-8,417	12,657	-0,665	0,506	1,000
Harry Gwala-Ugu	15,343	10,455	1,467	0,142	1,000
Harry Gwala-Umzinyathi	-17,867	14,761	-1,210	0,226	1,000
Harry Gwala-Zululand	-19,367	14,761	-1,312	0,190	1,000
Umgungundlovu-King Cetshway	-4,550	12,140	-0,375	0,708	1,000
Umgungundlovu-Ugu	11,476	9,823	1,168	0,243	1,000
Umgungundlovu-Umzinyathi	-14,000	14,320	-0,978	0,328	1,000
Umgungundlovu-Zululand	-15,500	14,320	-1,082	0,279	1,000
King Cetshwayo-Ugu	6,926	11,889	0,583	0,560	1,000
King Cetshwayo-Umzinyathi	-9,450	15,809	-0,598	0,550	1,000
King Cetshwayo-Zululand	10,950	15,809	0,693	0,489	1,000
Ugu-Umzinyathi	-2,524	14,108	-0,179	0,858	1,000
Ugu-Zululand	-4,024	14,108	-0,285	0,775	1,000
Umzinyathi-Zululand	1,500	17,538	0,086	0,932	1,000

Each row evaluates the null hypothesis that the distributions of Sample 1 and Sample 2 are identical. The results show asymptotic significance for two-sided tests, with a significance threshold set at 0.050.

a. The significance values have been adjusted using the Bonferroni correction to account for multiple comparisons.

For example, there is a significant difference in the means between the districts of Mkhanyakude and Umgungundlovu ($p = 0.028$).

It is observed that Mkhanyakude (mean = 2.8) is perceived to have fewer political constraints and unethical practices than Umgungundlovu (mean = 4.3).

4.7.2 Structural Equation Model

Structural equation modeling (SEM) is a statistical technique applied to investigate complex correlations among latent and observable variables. By combining structural models alongside measurement models, it provides a framework for assessing and validating theories. SEM directly measures observable variables and deduces latent constructs from these measurements. Estimating the strength and direction of correlations between variables is made possible by this method. It also evaluates how well the model aligns with the data, and assesses the importance of specific paths and coefficients.

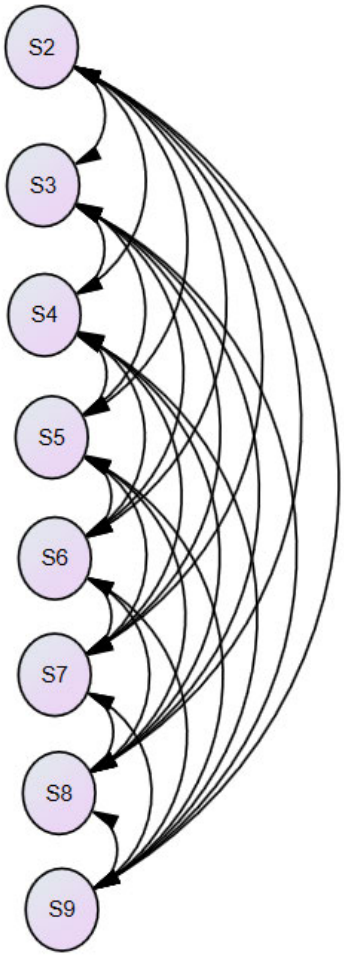


Figure 4. 7. Modified SEM

The model is a multivariate statistical outcome derived from structural relationships, utilizing a blend of factor analysis and multiple regression techniques. It is employed to examine the structural connections between observed variables and latent constructs. The dimensions are categorized under reliability.

4.7.3 RESULT (DEFAULT MODEL)

Minimum was achieved.
Chi-square = 535.470
Degrees of freedom = 274
Probability level = .000

The null hypothesis, according to this chi-square test, is that the just-identified (totally saturated) model suits the data more accurately than the overidentified (limited) model. In a just-identified model, each variable is directly connected to every other variable (without intermediary variables). In such a model, the chi-square value is zero since the fit is always perfect, and the probability should be non-significant. In this case, the chi-square p-value is < 0.050 ($p < 0.001$).

However, it is important to note that while the chi-square value should theoretically be non-significant in model testing, achieving this is often difficult due to the typically large sample sizes needed. Therefore, if the chi-square is significant, it is not necessarily a concern as long as other fit indicators are adequate.

Table 4.19: Maximum Likelihood Estimates

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
S3.4	<---	S3	.739	.097	7.614	***	par_1
S3.5	<---	S3	1.000				
S2.5	<---	S22	1.000				
S2.4	<---	S22	1.000				
S6.4	<---	S6	1.000				
S6.3	<---	S6	1.000				
S5.6	<---	S5	1.000				
S5.5	<---	S5	1.145	.115	9.983	***	par_2
S5.4	<---	S5	1.140	.123	9.298	***	par_3
S4.1	<---	S4	1.000				
S4.2	<---	S4	.869	.081	10.667	***	par_4
S4.4	<---	S4	1.152	.087	13.234	***	par_5
S7.1	<---	S7	1.000				
S7.2	<---	S7	1.354	.159	8.500	***	par_6
S7.3	<---	S7	1.267	.146	8.669	***	par_7
S7.4	<---	S7	1.421	.162	8.747	***	par_8
S8.1	<---	S8	1.000				

			Estimate	S.E.	C.R.	P	Label
S8.4	<---	S8	.774	.072	10.687	***	par_9
S8.5	<---	S8	.969	.074	13.031	***	par_10
S8.6	<---	S8	1.000				
S8.7	<---	S8	1.025	.063	16.248	***	par_11
S9.9	<---	S9	1.000				
S9.8	<---	S9	1.025	.111	9.269	***	par_12
S9.7	<---	S9	1.106	.088	12.499	***	par_13
S9.6	<---	S9	.887	.105	8.437	***	par_14
S9.5	<---	S9	.973	.108	9.007	***	par_15

The variables loaded strongly along their various factors (significant p-values indicated by *** $p < 0.001$). These confirm the EFA obtained under factor analysis.

Table 4.20: Standardized Regression Weights: (Group number 1 - Default model)

			Estimate
S3.4	<---	S3	.691
S3.5	<---	S3	.897
S2.5	<---	S22	.655
S2.4	<---	S22	.655
S6.4	<---	S6	.638
S6.3	<---	S6	.613
S5.6	<---	S5	.808
S5.5	<---	S5	.892
S5.4	<---	S5	.832
S4.1	<---	S4	.873
S4.2	<---	S4	.824
S4.4	<---	S4	.936
S7.1	<---	S7	.766
S7.2	<---	S7	.829
S7.3	<---	S7	.843
S7.4	<---	S7	.853

			Estimate
S8.1	<---	S8	.830
S8.4	<---	S8	.776
S8.5	<---	S8	.849
S8.6	<---	S8	.901
S8.7	<---	S8	.917
S9.9	<---	S9	.878
S9.8	<---	S9	.757
S9.7	<---	S9	.896
S9.6	<---	S9	.709
S9.5	<---	S9	.742

Maximum Likelihood (ML) approaches are utilized to determine the parameters in an iterative manner with the goal of optimizing the likelihood that the anticipated values of the criterion variable are correct. Every coefficient was higher than the suggested cutoff of 0.600. Items with unnecessary content or poor loadings were taken out of the model.

4.7.4 Model Fit Summary

The recommended acceptable value for the relative chi-squere, CMIN/DF, shouldn't exceed 5 in order to lessen reliance on sample size. Yet, the cut-off points for the Tucker-Lewis index (TLI), comparative fit index (CFI), normed fit index (NFI), and (incremental fit index) IFI are between zero and one. A good model is indicated by a root mean square error of approximation (RMSEA) value of less than or equal to 0.05.

Table 4.21: CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	103	535.470	274	.000	1.954
Saturated model	377	.000	0		
Independence model	26	2329.867	351	.000	6.638

CMIN is a chi-square statistic that evaluates the tested model against both the independence model and the saturated model. The ratio, CMIN/DF, also known as relative chi-square, indicates the extent to which the model's fit has deteriorated by removing one or more paths.

The CMIN/DF value is below the acceptable threshold of 5 (at 1.954), satisfying the CMIN criterion.

Table 4.22: Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.770	.706	.873	.831	.868
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Goodness of fit indices evaluate the model by comparing it to the independence model, rather than the saturated model. The Normed Fit Index (NFI) is calculated as the divergence between the chi-squares of the two models divided by the chi-square of the independence model. For this dataset, the NFI is 0.770, which falls short of the ideal value of 0.90 for a strong fit. The Comparative Fit Index (CFI) uses a related method called noncentral chi-square and is considered a dependable measure even with small sample sizes. It ranges from 0 to 1, with a value of 0.90 indicating a good fit. The CFI value here is 0.868, suggesting it is close to a good fit.

Table 4.23: RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.097	.085	.109	.000
Independence model	.235	.226	.244	.000

The root mean square error of approximation (RMSEA) measures how poorly a model fits compared to a saturated model. The p-of-close fit (PCLOSE) is a statistical metric used to evaluate model fit. An RMSEA value of 0.05 or lower indicates a "close fit," while a value between 0.05 and 0.10 suggests an acceptable fit. According to this criterion, a PCLOSE p-value above 0.05 implies that the RMSEA is below 0.05, signifying a close fit for the model. In contrast, a p-value under 0.05 informs that the model's fit is less than ideal.

For the initial model, the PCLOSE value was less than 0.001, falling short of the recommended threshold of 0.05. This indicates that the model did not achieve a close fit. Adjustments were

made to the structural relationships among variables, and this iterative refinement helped enhance the model's fit.

4.8 REGRESSION ANALYSIS

The strength of the linkages determines the amount of relevance. Below are tests of the correlations.

Table 4.24: Covariances: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
S3	<-->	S22	.435	.093	4.697	***	par_16
S22	<-->	S4	.465	.101	4.614	***	par_17
S22	<-->	S7	.366	.075	4.883	***	par_18
S22	<-->	S8	.416	.092	4.545	***	par_19
S9	<-->	S22	.327	.077	4.239	***	par_20
S22	<-->	S5	.267	.073	3.652	***	par_21
S22	<-->	S6	.011	.058	.190	.849	par_22
S3	<-->	S4	.640	.127	5.056	***	par_23
S3	<-->	S7	.498	.096	5.206	***	par_24
S3	<-->	S8	.617	.117	5.277	***	par_25
S9	<-->	S3	.410	.094	4.368	***	par_26
S3	<-->	S5	.275	.086	3.214	***	par_27
S3	<-->	S6	.079	.070	1.141	.254	par_28
S4	<-->	S7	.376	.090	4.165	***	par_29
S4	<-->	S8	.772	.136	5.663	***	par_30
S9	<-->	S4	.546	.109	4.995	***	par_31
S5	<-->	S4	.384	.097	3.937	***	par_32
S6	<-->	S4	.077	.074	1.039	.299	par_33
S7	<-->	S8	.395	.087	4.556	***	par_34
S9	<-->	S7	.302	.072	4.220	***	par_35
S5	<-->	S7	.246	.067	3.696	***	par_36
S6	<-->	S7	.014	.049	.283	.777	par_37
S9	<-->	S8	.592	.106	5.600	***	par_38
S5	<-->	S8	.506	.101	5.030	***	par_39

			Estimate	S.E.	C.R.	P	Label
S9	<-->	S5	.343	.080	4.304	***	par_40
S6	<-->	S5	.036	.056	.645	.519	par_41
S6	<-->	S8	-.047	.069	-.679	.497	par_42
S9	<-->	S6	-.058	.058	-1.000	.317	par_43

Table 4.25 Correlations: (Group number 1 - Default model)

			Estimate
S3	<-->	S22	.748
S22	<-->	S4	.719
S22	<-->	S7	.858
S22	<-->	S8	.680
S9	<-->	S22	.640
S22	<-->	S5	.552
S22	<-->	S6	.033
S3	<-->	S4	.702
S3	<-->	S7	.827
S3	<-->	S8	.714
S9	<-->	S3	.569
S3	<-->	S5	.403
S3	<-->	S6	.167
S4	<-->	S7	.563
S4	<-->	S8	.805
S9	<-->	S4	.682
S5	<-->	S4	.506
S6	<-->	S4	.145
S7	<-->	S8	.624
S9	<-->	S7	.572
S5	<-->	S7	.492
S6	<-->	S7	.040
S9	<-->	S8	.781
S5	<-->	S8	.704

			Estimate
S9	<-->	S5	.572
S6	<-->	S5	.091
S6	<-->	S8	-.093
S9	<-->	S6	-.139

Null hypothesis: There is no correlation between each of the dimensions.
Alternate hypothesis: There is a significant correlation.

Overall, if the covariance between two constructs is statistically significant, the correlation between them is likely to be significant as well. This is because correlation is a normalized version of covariance, and both measure the strength and direction of the relationship. All significant correlations have a p-value of less than 0.001, indicating a strong, positive relationship between the latent variables, with each correlation estimate (r) being positive. However, seven of the relationships are not statistically significant, with p-values greater than 0.05.

4.9 Direct quotes and Narrative Description from the interviews

The interviews were compiled and structured into questions that addressed the issue of tendering process at KZN DPW. A total of thirty professionals were identified and interviewed. These questions were as follows:

- Place of interview
- Qualifications of the interviewee
- Position of the interviewee
- Work complexity
- Effectivity of the work
- Type of tendering system currently used
- The loopholes of the current system
- The effectiveness of the used tendering system
- The project experience in relation to time, cost overruns as well as incidents and accident
- Normal mistakes happened
- The understanding automated tendering.

- Comments on the automated tendering.

The interviews were held with 30 respondents, 10 respondents are from Ethekwini region, 5 are from inland region, 4 from Umkhanyakude region as well as 5 contractors and 3 consultants. 90 % of interviewees hold degrees in built environment. Majority of respondents are project management with KZN DPW and 80% have handled complex project. 100% of interviewees are still using manual system and they have appointed contractors with the manual system and therefor that have impact on project cash overruns, program delays, incidents and accidents. Interviewees have highlighted normal mistakes such as system manipulation and 90% of interviewees suggested that automated tendering model be used.

4.10 SUMMARY

In structural equation modelling (SEM), the chi-square test is employed to evaluate how well the observed data aligns with the proposed model. The acceptability of a chi-square value is influenced by factors such as degrees of freedom, significance level, and related fit indices. In this study, the chi-square statistic is 535.470 with 274 degrees of freedom, yielding a very low probability value of less than 0.001. This indicates a significant deviation between the observed data and the estimated model. Generally, a non-significant chi-square value ($p > 0.05$) would indicate a good fit; however, in this case, the chi-square is significant.

It is crucial to recognize that the chi-square test is highly sensitive to sample size, and larger samples can produce significant chi-square values even with minor discrepancies between the model and the data. Thus, depending solely on the chi-square statistic may not provide a full picture of the model's fit. For a more thorough assessment, it is advisable to also regard other fit measures, such as the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). In this context, the CFI value of 0.868 suggests an adequate fit (values above 0.90 are deemed acceptable), while the TLI value of 0.831 points to a moderate fit (values over 0.90 indicate good fit). The RMSEA value of 0.097 falls in the moderate range (values between 0.05 and 0.10 are considered acceptable). Considering all these fit indices together, it appears that while the chi-square test does not show a perfect fit, the other indices indicate a reasonably satisfactory fit for the model. It is important to interpret these fit indices collectively rather than relying solely on the chi-square result.

Some statements with low loading factors were excluded from the model. High factor loadings were revealed by examining the coefficients for each latent variable, and the path coefficients—which are represented in the diagram—were all positive, suggesting a proportionate relationship among the latent variables.

Given that this is a recently formed concept, some disarray in the structural relationships may be anticipated. Nonetheless, some indices satisfy the requirements, indicating that the model fits the data well enough. To improve factor loadings, it is advised to make changes to the model with regard to the measured variables that make up the latent variables.

4.11 CONCLUSION

Data was collected for the automated tendering process, using various testing models to validate it accuracy. The following tests were used in the data analysis: mean scores, binomial test, chi-square test, reliabilities, factor analysis, Kruskal-Wallis test, and mean by biographical. This study ranked the factors explored by their average mean scores on tendering process issues and the development of automated tendering processes. The leading factor during the tendering process was corruption constraints. Political constraints and unethical practices followed closely. Poor planning of tendering was the third factor, and the professional team's competency ranked as the fourth factor. The preceding chapters factors analysis necessitates that all acknowledged aspects for each category satisfactorily describe the subproblems, with loadings greater than 0.50 in all cases.

Each category was reviewed, and the factors that impact each tendering process were identified. This highlights the importance of developing an automated tendering process to streamline the tendering process at the KZN Department of Public Works.

The development of an automated tendering process can mitigate highly ranked issues such as corruption constraints and unethical practices. The construction industry is one of the biggest sectors in South Africa, and it will contribute 24% in 2022. This means that factors such as corruption and unethical practices in construction need to be mitigated, as they can affect the entire South African economy. It is therefore suggested that this feasibility study of the development of automated tendering processes be implemented.

CHAPTER 5: PRESENTATION OF MANUAL TENDERING PROCESS BY KZN DPW

5.1. Introduction to manual tendering and tender strategy

The tendering process encompasses a series of steps that are vital for moving goods or services from the initial requisition stage to the creation of purchase orders and the approval of invoices (Sahay et al., 2020). This process includes several key components, such as determining requirements, researching suppliers, conducting value analysis, initiating a tender request, undergoing a review phase, converting it into a tender order, managing contracts, overseeing the receipt of orders, performing a three-way match, fulfilling payment obligations, and maintaining records (Sahay et al., 2020). Each of these phases plays a crucial role in the procurement cycle.

Tendering can be seen as a systematic discipline; it involves the logical organization of various elements—such as labour, materials, and equipment—into a standardized sequence. This sequence includes factors like labour output, which is typically based on historical data (Cloete, 2005). Cloete (2005) further mentions that there are tender procedures, which are as follow:

A tender strategy must guide the tendering of engineering and construction services. This strategy is selected by the project manager and approved by the bid specification committee (BSC) before procurement by the Department of Public Works takes place. This strategy shall include:

a) The procurement procedure,

b) The evaluation method,

c) The applicable preference point system,

d) CIDB (Contractors Industry Development Board) contractor grading designation, and

e) Socio-economic objectives.

This strategy will assist in achieving “targeted preferential procurement objectives” set by KZN’s public works departments in accordance with their tendering plan. The requisition form for tendering strategy must be filled out by the project manager in coaction with the principal agent or consultants (KZN DPW SOP 2013). The project manager must tick off whether the

project is an engineering project or a construction project, the threshold value, the estimated value, the CIDB grading of the contractor, the contract form, the tender criteria, the preference point scoring system, the price and functionality weighting applicable to the tender, the preference points system goals, the expanded public works programme (EPWP) elements, the emerging contractor development programme element, the tender validity period, additional comments, and onward transmission to BSC.

5.1.1. Invitation to tenders

i. Spreadsheet for the monitoring of the progress of tenders

A member of the Procurement and Pre-Bid Division of the Acquisition Management Sub-directorate must be assigned the duty to monitor and capture on computer the tender processes for each tender which will serve as a progress tracking tool and ensure that tender validity periods are not allowed to lapse. Each member of this division who is assigned different tender duties to perform according to the various tender processes must ensure that the official is given details of the progress being made with projects until contract awards are made. At the beginning of each week, the assistant manager of the division must be given a computer printout of this progress to monitor and initiate proactive and corrective measures that are deemed necessary to avoid the expiry of tenders. The programme management, project manager and principal agent must be given a weekly courtesy copy as well.

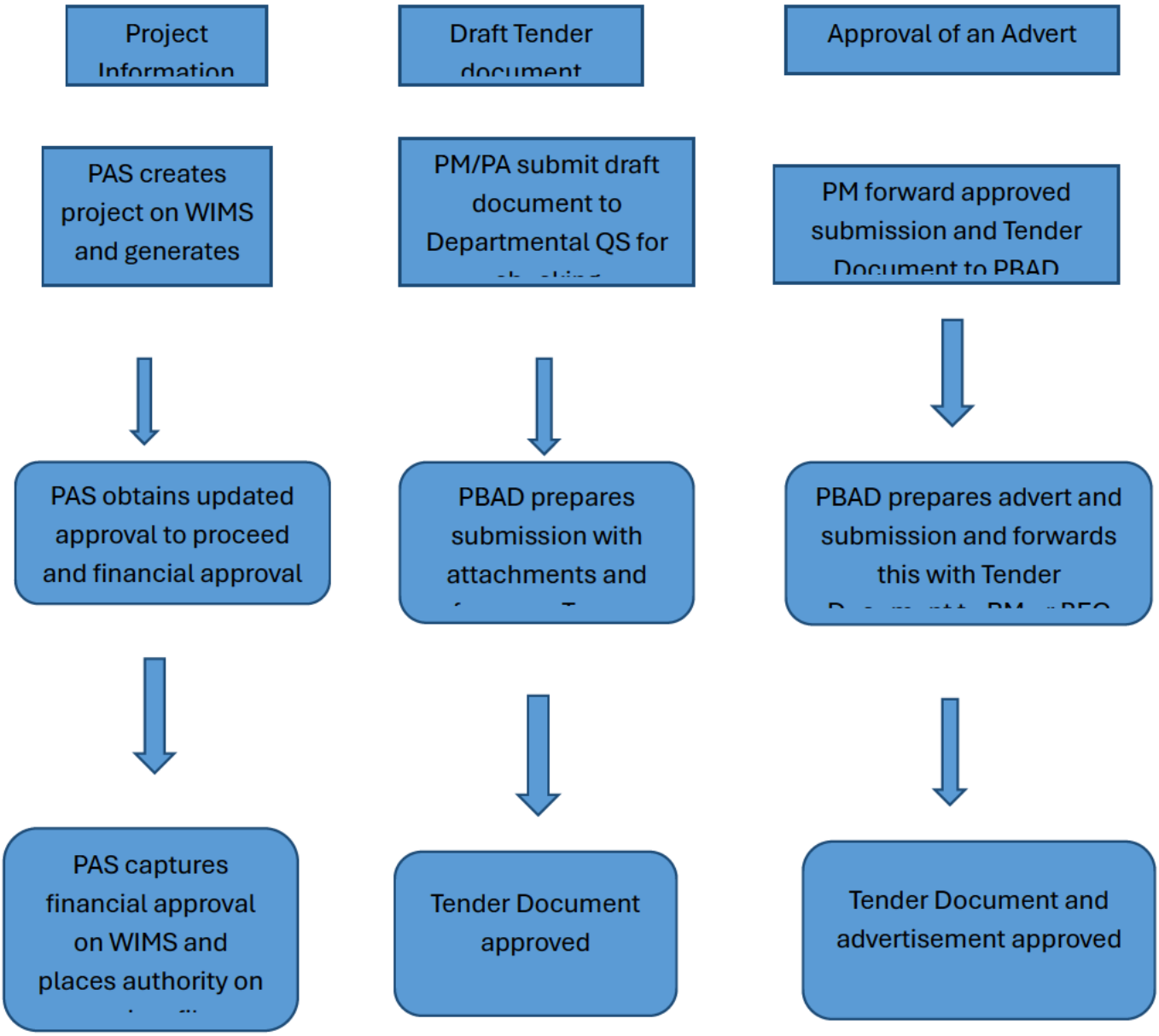


Figure 1. 1: Approval of tender document to advertise - above R 500 000 including vat.

Key:

PAS: Programme Administration Section

PM: Project Manager

PA: Principal Agent

BSC: Bid Specification Committee

BEC: Bid Evaluation Committee

BAC: Bid Adjudication Committee

RM: Regional Manager

PBAD: Pre-Bid and Adjudication Division

ii. Tender number and tender documentation information relating to obtaining approval to advertise.

Tender numbers will be generated by the works information management system (WIMS) automatically. This number will be linked to the WIMS number. The tender number will be generated as follows: The first three characters will be ZNT, followed by the letter of the category code linked to the service, which will indicate the region, followed by a 5-digit number system generated in sequence and ending with a W. Close to the time for the receipt of the draft tender document the programme administration section of the programme management sub-directorate must obtain approval to proceed and financial authority for the estimated cost from the client department or a delegated official if it is a project for the Department of Public Works. The Programme Administration Section must record the confirmation on the WIMS screen PBS-U and the cost estimate on the WD01PU screen.

5.1.2. The project manager

Once a project has been fully documented, the project manager, principal agent or consultant, and departmental professional quantity surveyor or engineer must carefully check the draft tender document to ensure that it has been accurately compiled. A compliance certificate and Certificate of Correctness form (DOW019) must be completed by the consultant for the project manager to acknowledge. The draft tender document and a full set of drawings, if applicable, together with the Certificate of Correctness form (DOW019), the estimate of cost (DOW017), and memoranda DOW303 or DOW306 must be submitted to the Secretariat of the Regional Bid Specification Committee. The bid specification committee must verify whether all the quality assurance standards have been met regarding the type of service that is requested. This committee is ultimately responsible for ensuring that the draft tender document is properly

compiled regarding the specifications and tender evaluation criteria and confirming that the socio-economic objectives have been achieved. If the draft tender document is found to be in order, the members of the bid specification committee will sign either DOW303 or DOW306 and them to the project manager to update the WIMS screen PBS-U and to pass all documentation to the Pre-Bid and Adjudication Division of the Acquisition Management Sub-directorate for further action.

5.1.3 Pre-Bid and Adjudication Division

Request for approval of Tender Document and Advertisement utilizing Supply Chain Management delegation.

i) The Pre-Bid and Adjudication Division is tasked with preparing the submission for advertisement utilizing specimen 1, directed to the Bid Adjudication Committee (BAC).

ii) Additionally, a draft advertisement, serving as a notice and invitation to tender, must be prepared as annexure A (DOW304) to the advertisement submission.

iii) The project manager and the Chairman of the Bid Evaluation Committee (BEC) must submit the original, signed submission to the Bid Adjudication Committee, along with six (6) copies and one (1) set of tender documents.

5.1.4. Advertisements

i. Advertising mediums

Tenders are invited by using the following mediums:

(i) Government Tender Bulletin,

(ii) Newspapers (Widely distributed KZN English and IsiZulu newspapers), and

(iii) CIDB website: i-Tender facility.

ii. Advertisement of tender on the CIDB website

All tenders for engineering and construction works must be advertised on the CIDB website i.e., through the i-Tender@CIDB address. Advertisements must be placed on this website at least 10 working days before the closing date for tenders and at least five (5) working days before any compulsory official briefing/site inspection meeting. Only those officials who have

been authorised and assigned a user number by the CIDB to perform functions on its site may attend to this duty.

5.1.5. Procedure for placing Tender Advertisements in the Government Tender Bulletin and Newspapers

Once the approval of the draft tender document and advertisement thereof is received from the manager for projects valued from R500 000 up to R1million or from the bid adjudication committee for projects valued at R1million and above, the pre-bid and adjudication division will arrange for the placement of advertisements in the Government Tender Bulletin, newspapers and on the CIDB website.

The advertisements will be placed in the Government Tender Bulletin, the Ilanga, and the Natal Mercury to ensure effective placement. The Government Tender Bulletin is published on Fridays, and the newspapers advertisement should appear on the same weekday. Other media may be utilized in addition to the above. The Government Tender Bulletin, issued by the Government Printing Works in Pretoria, is published by the Government Printing Works based in Pretoria, is published every Friday. Officials tasked with arranging the publication of tender notices should note that it typically takes the Government Printer one week to publish such notices. This one-week lag must be taken into consideration when determining the availability of the tender document and setting the closing date. These dates must be observed when determining the compulsory official meeting/site inspection date, time and venue.

Advertisements meant for the Government Tender Bulletin need to be submitted by 15:00, at least one week before the scheduled publication date. If a Friday falls on a public holiday, the release date will be moved to the day before the holiday. In such cases, the deadline for submitting advertisements is pushed back by five working days from the publication date.

Notices that arrive after the specified cut-off time will be postponed and included in the following edition of the Government Tender Bulletin. The Pre-Bid and Adjudication Division will liaise with the project manager or consultant to schedule the compulsory official briefing meeting/site inspection and the closing date. The Pre-Bid and Adjudication Division must confirm the set dates in writing with the project manager or consultant by using DOW008. The Pre-Bid and Adjudication Division must also request that the project manager or consultant print sufficient tender documents for tenderers as outlined in DOW008. This cohesive approach ensures smooth co-ordination and adherence to publication and meeting schedules. Before

deciding on the closing and site inspection meeting dates, it is crucial to allow a reasonable period to:

(i) Print the required number of documents.

(ii) Collate the printed documents.

(iii) Check for their accuracy and correctness.

(iv) Bind the tender documents.

(v) Deliver the documents to the department for issue to tenderers.

The tender must be advertised for at least 21 calendar days before its closure. All tender documents should be available by the publication date of the advertisement. In justifiable circumstances, the accounting officer or delegated authority may consider shortening the closing date; however, this should not disadvantage any potential contractors from tendering by allowing adequate time for tender pricing. The closing date for receipt of tenders and, if necessary, the compulsory briefing meeting/site inspection date must be indicated in both T1.1 – Notice and Invitation to Tender and T1.2 – Tender Data Form as contained in the tender document and must be checked for correctness by the project manager or consultant to ensure that the information has been accurately recorded.

5.1.6. Advertisement Procedures

i. Newspaper Media

The Pre-Bid and Adjudication Division must use form DOW100 and the attached Notice and Invitation to Tender Notice and form DOW304, which is attached to the submission for approval to advertise the project to request the newspaper media by fax to each submit a quotation and a typed version of the Notice for checking. The newspaper address list is detailed on Form DOW102.

ii. Government Tender Bulletin

Similarly, submit a request to the Government Printing Works, Pretoria, to arrange for the service to be advertised in the Government Tender Bulletin, using form DOW101 together with the typed version of the Notice and Invitation to Tender, form DOW304, which is attached to the submission for approval to advertise the project. The Basic Accounting System and Standard Chart of Accounting transaction codes are reflected on form DOW101 to enable the

Government Printing Works, Pretoria, to recover expenditure from the Department of Public Works. Upon receipt of the advertisement publication cost from the Government Printing Works, the Pre-Bid and Adjudication Division will request the provisioning division urgently prepare an official order and forward it by facsimile transmission to that department for further action. Thereafter, the official order is to be posted to the Government Printing Works. Copies of these transactions must be placed in the project file. Upon receipt of the quotations, the typed versions of the newspaper's advertisement must be carefully checked for accuracy, and if necessary, they must be clearly amended, and the relevant newspaper office must be notified to effect corrections. The Pre-Bid and Adjudication Division is responsible for this action. The provisioning division of the Acquisition Management Sub-directorate must prepare the official order for the newspaper and, using DOW305, send a letter to the newspapers indicating that the quotation is acceptable. The order number must be provided. Copies of these transactions must be placed on the project file. On publication of the advertisements (in both newspapers and the Government Tender Bulletin), it is imperative to check their correctness and, if incorrect in any way, take remedial action immediately. A copy of the Notice and Invitation to Tender, form DOW304 must be displayed on the foyer notice board of the office responsible for advertising tenders. A copy of the Government Tender Bulletin advertisement must be placed on the project file.

5.1.7. Matters for the Compulsory Official Briefing Session

i. Attendance

Before an advertisement is published, the project manager or consultant must decide whether a compulsory official briefing session or site inspection is required, and if so, it must be stated in the advertisement and tender documents. An official briefing session or site inspection will only be held if the tender advertisement clearly states that it is compulsory.

An attendance register (form DOW0120) must be prepared before the briefing session to ensure that there are sufficient pages in the attendance register to cater for at least those tenderers who have already drawn tender documents up to the day prior to the set date of the pre-tender meeting or site inspection. Also, allowances must be made for other tenderers who may wish to draw tender documents prior to the start time of the meeting. No tender document must be issued to tenderers after the close of the meeting. Tenderers must complete Form DOW010—acknowledgement of receipt of tender documents.

ii. Conducting the meeting

The project manager will chair the meeting or nominate a person with sufficient knowledge of the project. The following items must be discussed:

(i) The importance of completing the tender document accurately and thoroughly, ensuring all necessary signature are provided and all the required supporting documentation are included

(ii) The tender must be submitted in a sealed envelope with the tender number, description of service, closing date, and name and address of the tenderer written clearly on the envelope.

(iii) The tax clearance certificate requirements in the KwaZulu-Natal Provincial supplier's database registration, CIDB Registration and the Preference Point Schedule.

5.1.8. Issue of Tender Documents to Contractor

A complete set of tender documents is issued free of charge to bona fide contractors. Form DOW011, titled, Documents given to contractors, must be completed, which will form an eventual composite record of all tenderers who have taken tender documents.

On issue of a tender document, form DOW010, titled, acknowledgement by prospective tenderer of receipt of tender document at site inspection, must be completed by the tenderer and placed on file, especially opened, containing the ZNT tender number and service description.

The details of tenderers who have taken documents are retained in case it is necessary to:

(i) Issue an addendum to amend or amplify tender documents, or

(ii) Extend the closing date.

The stock of documents on hand must be monitored. When the stock level reaches five (5) and there is still enough time for tenders to close, the project manager or consultant must be requested to print more documents.

5.1.9. Submission of tenders

i. Tender Openings

Tender submissions will be opened in the presence of bidders or their authorized representatives who opt to be present at the specified time and location mentioned in the tender

documents. Two authorised officials of the Pre-Bid and Adjudications Division will oversee the opening of the tender box, who will assist in the process and act as witnesses, in case of queries from the public or tenderers themselves. Given the possibility of multiple tenders closing simultaneously, upon removing the documents from the Tender Box, efforts will be made to separate the different tenders, by placing alike ones together. Both the tender envelope and the form of offer submitted by each tenderer must be stamped, indicating the closing date and time and initialled by the officials undertaking this task. Furthermore, a sequential numbering system will be applied to each tender, denoted by consecutive numbers such that if, for instance, if 20 tenders are received, the first tender number should be marked 1/20 and the last tender as 20/20. on the right-hand top corner of the form of offer.

The following information may be announced at the public opening of a tender:

a) The name of each tenderer.

b) The total price (financial offer) of each tender or alternative tender offer, except where the number of items or the complexity of the tender makes it impractical.

A register of tenders received must be kept. The names of each tenderer and the tender price submitted must be recorded in schedule form in duplicate and signed by both officials authorised to open the tenders. This will serve as the official record of the receipt of tenders. One copy must accompany the tenders to be evaluated.

ii. Late Tenders

A tender offer must be submitted on or before the closing date and time and at the address stated in the Notice and Invitation to Tender. Tenders received after the stipulated closing time or tenders that are not delivered in accordance with the instructions given to tenderers shall not be considered and must be returned unopened. If the envelope does not have a return address on it, then it will have to be opened to establish this information. If the tenderer refuses to take back the late tender, indicate the date and time of receipt on the envelope and sign it. A letter must be sent to the tenderer together with his/her tender indicating the time the tender was received and that late tenders are not accepted.

5.1.10. Scheduling of Tenders Received

The Pre-Bid and Adjudication Division will schedule all tenders, listing the lowest tender first through to the highest one received. A copy of this schedule is placed on the notice board for general information.

5.1.11. Forwarding of Tender or Quotation Documents for Evaluation

As soon as practical, the tender documentation must be submitted to the project manager or consultant for evaluation purposes within 10 days. It would be wise to arrange for the documents to be collected and signed for. The Pre-Bid and Adjudication Division must prepare the pre-evaluation (pre-screening) material for the project manager/consultant which includes:

a) Print-outs of the provincial supplier database registration confirmation,

b) The verification of the tax clearance certificate,

c) Information about tenderers who have been performing poorly on other projects and who have been given a written notification to this effect,

d) An electronic preform tender award submission together with an Excel preference point calculation schedule and any other information deemed important for the evaluation.

e) CIDB Registration.

Where an appointed consultant is responsible for undertaking the evaluation of tenders or quotations, Form DOW013 is completed, and they have ten (10) days to furnish a recommendation. Where the evaluation will be handled departmentally, a memorandum, worded the same as Form DOW013, must be issued to the responsible official and kept pending for follow-up purposes. Monitor the recommendation for a contract award. If it is not received within fourteen (14) days of the date of the letter requesting the responsible project manager or consultant to undertake the evaluation of tenders, follow up accordingly. Open a procurement file for evaluation. Classify this file as pending the outcome of the evaluation. If, after a month, the project manager or consultant has not submitted the evaluation report, notify them that the evaluation must be completed, or the validity of the tender will lapse.

5.1.12. Extensions to the Tender Validity Period

If the project manager or consultant pre-determines that the validity period for a tender or quotation needs to be extended, he/she must provide valid reasons in writing to the department. If the evaluation is delayed by the departmental committees, the procurance and post-bid section will determine the reasons to apply for an extension to a validity period for a tender or quotation. A submission must be prepared to the regional manager to seek an extension to a tender validity period, giving reasons for the request. Form DOW013A is used for this purpose. Approval to extend a validity period for a tender or quotation is granted by a regional manager in terms of SCM Delegation 4.10. The regional manager must contact all tenderers via fax, using form DOW013B, notifying them of an extension to the validity of a tender or quotation has been granted and enquiring if they are willing or not to extend the validity period of their tenders or quotations to the approved set date. The fax message confirmation, which includes the date and time of successful transmission, indicating the forwarded from DOW013B to each tenderer must be duly filed using the facsimile numbers specified by the tenderers in their tender offers. It is also advisable to alert tenderers by telephone of the request to extend the validity periods of tenders or quotations. On receipt of the written confirmation, whether in the affirmative or not, all concerned should be notified of the outcome to the matter.

5.1.13. Evaluation of Tenders

i. Revision of Estimate

Should it become necessary to revise the estimate after the receipt of tenders, then the new estimate must be utilized for the comparison of the tender prices received. However, the submission recommending a contract award must clearly state the reason for the revision and its details. Care must be taken to ensure that this happens only in exceptional cases. The breakdown of the revised estimate as reflected on Form DOW017 from the consultant must be attached to the submission. Should the revised estimate result in the Project moving to the next upper CIDB Grade, then in fairness the Tender should be cancelled and re-advertised.

5.1.14. Financial Authority

If the recommended tender amount exceeds the previously approved cost estimate, further authorization may be required.

5.1.15. Evaluation Process

An adjudicating evaluation team must be formed, comprising the project manager, consultants, and a supply chain management practitioner. The recommendation for a contract award must include their names, demonstrating their knowledge and lack of personal interest in the tender.

5.1.16. Elimination of Tenders

i. Determine whether tender offers are complete

(a) The tender proposal must be reviewed against the checklist of required documents outlined in the tender documents. Any missing or incomplete schedules and supporting documents must be identified.

(b) What is incomplete and missing must be recorded.

ii. Determine whether tender offers are responsive

(a) Any tender that does not comply with the responsiveness criteria specified in the tender document will be rejected.

(b) A responsive tender is one that, without any deviation or qualification, conforms to all the items, conditions, and specifications of the tender document. In essence, it fully meets the minimum conditions and standards that a tenderer must comply with for it to be regarded as having responded to the invitation to tender.

iii. Non-Responsive Tenders that do not comply with (ii) above:

(a) The tender offer has not been properly and fully completed and signed in ink.

(b) The tender offer does not meet the requirements of the Standard Conditions of Tender.

(c) The tenderer is not registered on the provincial supplier's database and on the CIDB register of contractors or is not capable of being registered prior to evaluation.

(d) The tenderer has not attended the compulsory official briefing/site inspection session.

(e) Alterations are made that do not conform to instructions.

(f) The tenderer has not observed pricing instructions.

(g) The tender offer does not cover the scope of work.

(h) The tenderer fails to provide additional information by the due date (within 14 calendar days).

(i) The tender offer contained material deviations or qualifications.

(j) The tender offer does not have an original and valid tax clearance certificate nor is the department in possession of one prior to the close of tender.

(k) The tenderer does not have a Certificate of Good Standing with the compensation commissioner.

(l) A tender submitted by a joint venture or consortium, will be rejected if every member of the joint venture or consortium is not registered on the CIDB register of contractors.

(m) If the Authority to Sign Tender is not signed/accompanied by a resolution authorising one of the directors, members or partners to sign the tender offer (this is to prevent a person employed by a company from submitting a tender without the knowledge and approval of the management).

(n) The compulsory enterprise questionnaire is incomplete.

5.1.17. Perform a Risk Analysis

i. Confirm that tenderer:

a) is not under any restrictions or has principals who are under any restrictions from participating in public procurement (i.e., not listed on the Register of Tender Defaults in terms of the Prevention and Combating of Corruption Activities Act of 2004 that prevents people from doing business with the public sector).

b) can demonstrate that he/she possesses the necessary professional and technical competence, financial resources, equipment and other physical facilities, managerial capability, reliability, experience, reputation and the personnel to perform the contract.

c) has the legal capacity to enter a contract.

d) is neither insolvent, in receivership, bankrupt, nor undergoing liquidation; is not under court or judicial administration; has not ceased business operations; and is not involved in any legal proceedings related to these issues.

e) has no conflicts of interest that could affect their capability to execute the contract in the employer's best interests.

f) has not met the obligations of an ongoing contract and has received formal written notification regarding this failure.

Even though CIDB provides information on the financial ability of a contractor to carry out projects of certain values, financial institutions must be approached for recommendations relating to a financial capability of a contractor to finance a proposed contract. Financial institutions typically require both a contract amount and a contract period to provide a rating. This will also include the letter of intent to guarantee performance. The reasons for declaring a tenderer nonresponsive should be documented. Aside from meeting the above requirements, the evaluation team may request a tenderer to submit any or all the following information that is required to evaluate a tender:

If the firm is a closed corporation, a certified copy of the Founding Statement (CK1) should be provided.

a) For a private company, a copy of the Articles of Agreement (CM1) and shareholding certificates endorsed by an auditor are required.

b) In the event that the tenderer is a public company, they must provide a letter from their auditors certifying their status as a public company and a certified copy of the tenderer’s Articles of Agreement.

c) If the firm is a company, the auditor should endorse a copy of the Articles of Agreement (CM1) and shareholding certificates.

d) The document must contain a certified copy or copies of the natural person's or partnership's identity document(s).

e) If the tenderer is a joint venture or consortium, they must provide a copy of the joint venture agreement.

f) If a trust claims preference points, a copy of the trust agreement is required.

5.1.18 Reduce tenders to comparative offers (financial offers where all factors of non-firm prices are considered)

i. Arithmetical errors, if applicable to the tender

Review responsive tender submissions for mathematical mistakes and make corrections as follows: If there is a difference between the amount written in numbers and in words, the amount in words will prevail. In cases where a Bill of Quantities (or Schedule of Quantities or Schedule of Rates) is applicable and there is an error in the line total caused by the multiplication of the unit rate by the quantity, the line-item total will take precedence, and the unit rate will be adjusted accordingly. If there is an obvious misplacement of the decimal point in the unit rate, the provided line-item total will govern, and the unit rate will be corrected. In instances where the total price is incorrect due to either necessary adjustments during the review process or errors in the tenderer's price addition, the tendered total price will take precedence. The tenderer will then be asked to amend specific item prices (and their rates if a bill of quantities was used) to match the tendered total price. Failure to correct or accept the proposed correction of arithmetic errors as outlined may lead to the rejection of the tender submission.

ii. Determine the reasonableness of tender offers

Assess the validity of the financial proposals and reject any tender submissions that contain unfeasible or unrealistic financial offers. Ascertain whether there is a valid reason for the tender price being unrealistic. If not, eliminate it from further consideration.

iii. Financial and other resource capabilities of tenderers

The Construction Industry Development Board (CIDB) assigns Grading designations and registers contractors based on their historical average annual turnover and evaluated operational capabilities. At the time of registration, a contractor should have adequate working capital to start and effectively execute a single contract without external financial support. Contractors often bid on multiple projects simultaneously, which may overlap in timing. Additionally, they might be engaged with contracts that match their registered CIDB Grading Designation or handle several smaller contracts. Consequently, it is the responsibility of the contractor to demonstrate to the department that their enterprise has the capability to manage more than one contract concurrently. It is neither the responsibility nor the role or concern of the Department of Public Works to spend valuable energy and money proving or not the

capabilities of a contracting business. A tenderer who wishes to be considered for other contract awards over and above the tender price prepared for the tender under review must prove by separate evidence as attachments to the tender that additional finances (inclusive of a performance guarantee to be provided by a resisted financial institution), human resource, equipment, plant and machinery can undoubtably be sourced.

5.1.19. Evaluate Responsive Tender Submissions

Evaluate tenders strictly in accordance with the evaluation method as specified in the procurement strategy and in accordance with the manner stated in the tender data of the tender document.

CIDB prescribes four methods of Evaluation.

Method 1: Financial Offer Price

Method 2: Financial Offer Price and Preferences

Method 3: Financial Offer Price and Functionality

Method 4: Financial Offer Price, Functionality, and preferences.

For tenders, the Department of Public Works can choose between Method 2, which is on a financial price and preferences basis and Method 4 which is on a financial, functionality and preferences basis. For engineering and construction works, the use of “functionality” in evaluation must only be selected for projects of a complex nature, for example, a design and build project where quality is of paramount importance.

5.1.20. Award of Tender

All tenders (value exceeding R500 000) are evaluated by an adjudicating team, which is responsible for preparing a submission recommending a contract award. This submission is to be signed by the project manager and forwarded to the Regional Bid Evaluation Committee for endorsement and approval before being presented to the Bid Adjudication Committee the proposed contract award.

The concurrence to the contract award by the Regional Bid Evaluation Committee must be noted on Form DOW014A and the approval granted by the Bid Adjudication Committee is to

be recorded on Form DOW014B. All contract awards greater than R1m must be validated by the accounting officer (Head of Department) (SCM Delegation 4.3) must validate all contract awards exceeding R1m, with the exception of period or exemption contracts, for which the contractors have obtained preapproval.

5.1.21. Advertising of Results

Once contract awards Level 4 tenders have been approved by the Bid Adjudication Committee and, if necessary, validated by the accounting office (Head of Department), then the details of the award, for instance, tender details and the name of the contractor, must be advertised by the Procurement and Post Bid Division of the Acquisition Management Sub-directorate in the Government Tender Bulletin as per SCM Delegation 4.3.

All contract awards must be registered by an authorised official on the CIDB Project Register, using the following website address: www.cidb.org.za. The domino effect of registering contract awards on the CIDB website is that it provides information on the nature, value and distribution of projects while also recording the performance and development of contractors. All contract award results must be displayed on the foyer notice board of the office concerned.

5.1.22 Tenders Appeals Tribunal

Any tenderer aggrieved by a decision of the Bid Adjudication Committee or delegated manager may lodge an appeal with the Bid Appeals Tribunal. Appeals will be dealt with by the Bid Appeals Tribunal in accordance with the KwaZulu-Natal Supply Chain Management Policy Framework as issued by Provincial Treasury and Practice Note Number: SCM-07 of 2006. The Secretariat of the Tender Appeals Tribunal will notify the Department of Public Works when it is to proceed with the award of a contract.

5.1.23. Handing Over the Form of Offer and Acceptance and "Commencement Date"

Once the award is made by the Bid Adjudication Committee and the appeal period has passed, ensure that the “acceptance” portion of the form of offer and acceptance is signed and dated on behalf of the Department of Public Works (Employer) by the official with the delegated authority in terms of SCM Delegation 4.16. Specimen 4 is an example of a submission to use for this purpose. The signed form of offer and acceptance must not be handed over to the contractor until site handover.

A letter of intent for a contract award, Form DOW309 (JBCC), must be sent to the contractor, notifying him or her that the Department of Public Works can only furnish him or her with a full copy of the form of offer and acceptance upon receipt of proof of insurances and the Construction Safety, Health, and Environmental Plan, and where bills of quantities are required, a priced copy of the Bills of Quantities. Form DOW310 (GCC) is to be used.

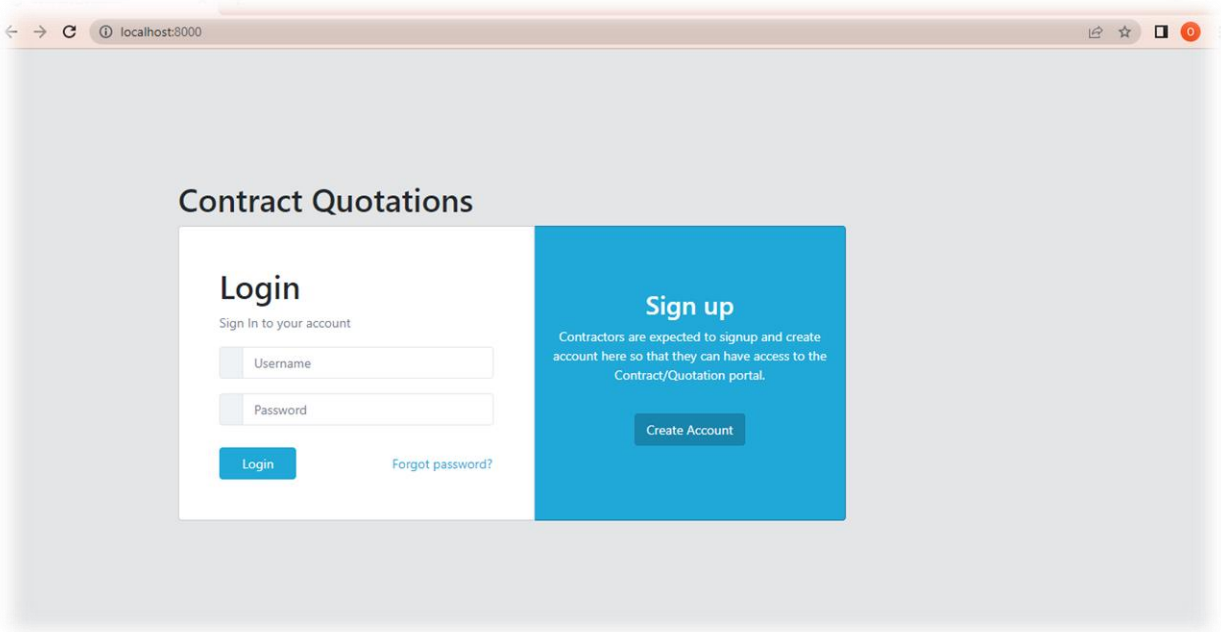
At the time of site handover, which will mark the "commencement date" of the contract, the contractor will receive a duplicate of the document of consent and offer.

5.2 INTRODUCTION

Presentation of feasibility automation programme

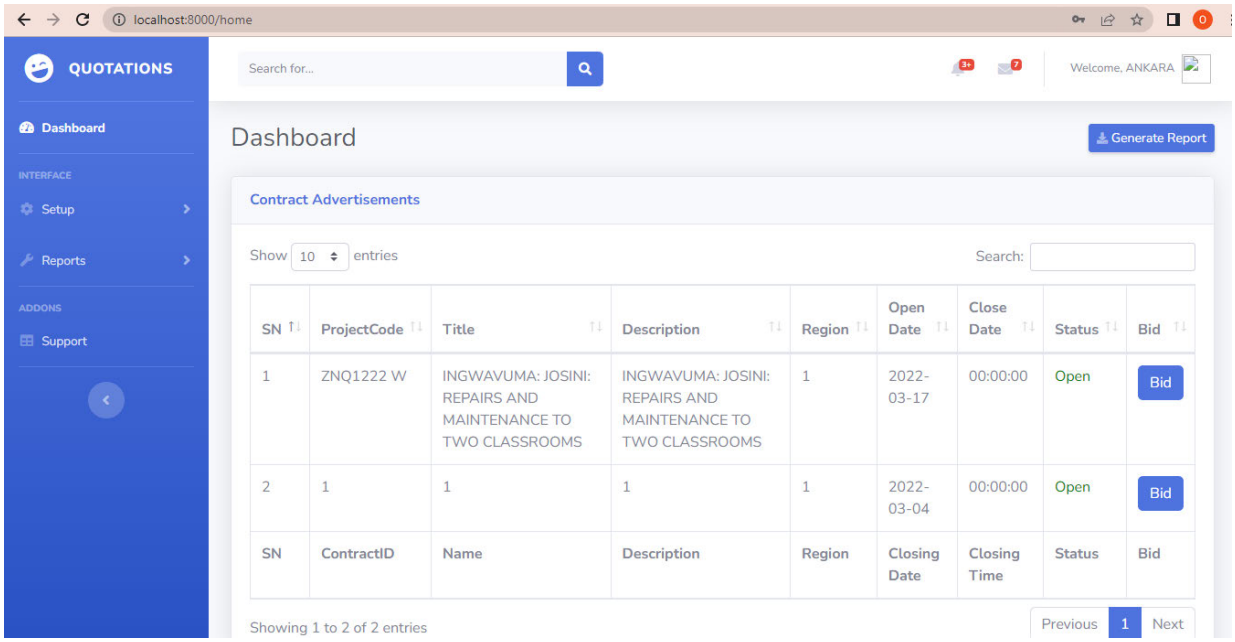
This chapter presents and discusses the automation programme of the tendering system. The programme focuses on the development of an automation tender process for the KwaZulu-Natal Department of Public Works. This chapter includes slides featuring screenshots from the main app, illustrating how to operate this app as part of the automation process. Both the administrator and the user operate this app for the tendering process, and as Chapter 4 presented the need for automated tender processes, this chapter presents the operation of the automated tender processes.

5.2.1. CONTRACT QUOTATION PAGE

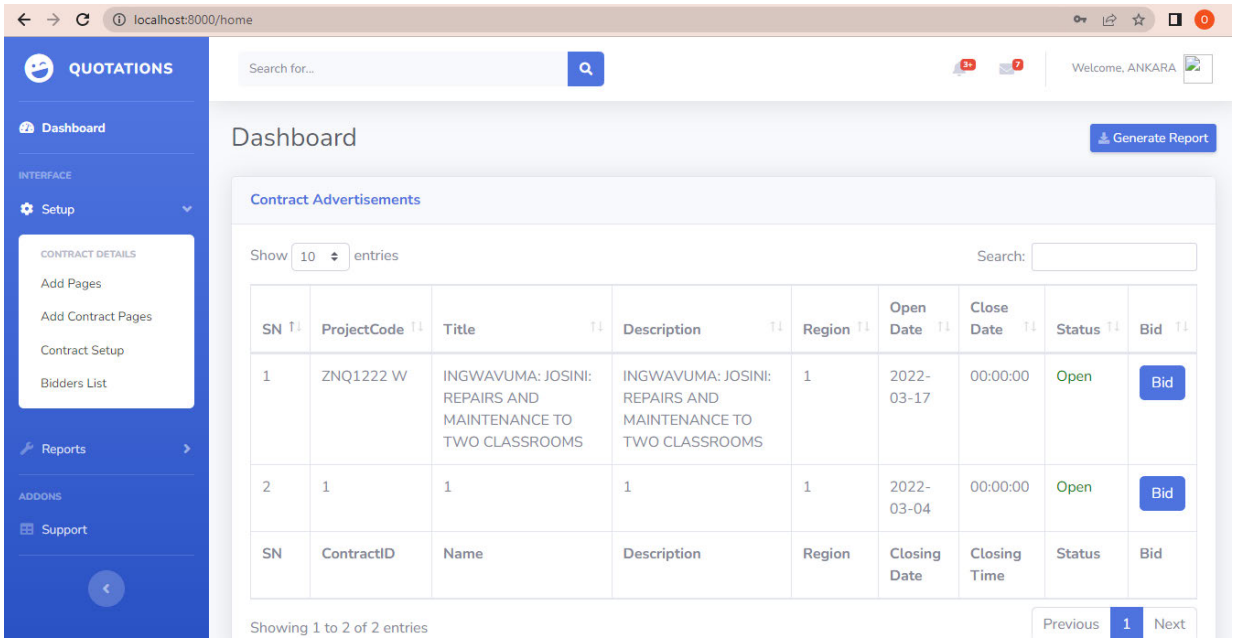


This page serves as the login portal for both administrators and regular users to access the application. The application caters to two major user groups, namely, the users (who are the contractors bidding and submitting quotations for contracts) and the administrator (who manages all the activities of this application). The application features two distinct user roles: user role and admin role each endowed with specific permissions for each of the users. The admin role is superior to the user role which means the admin role has power to manage the activities of the user.

5.2.2. THE DASHBOARD

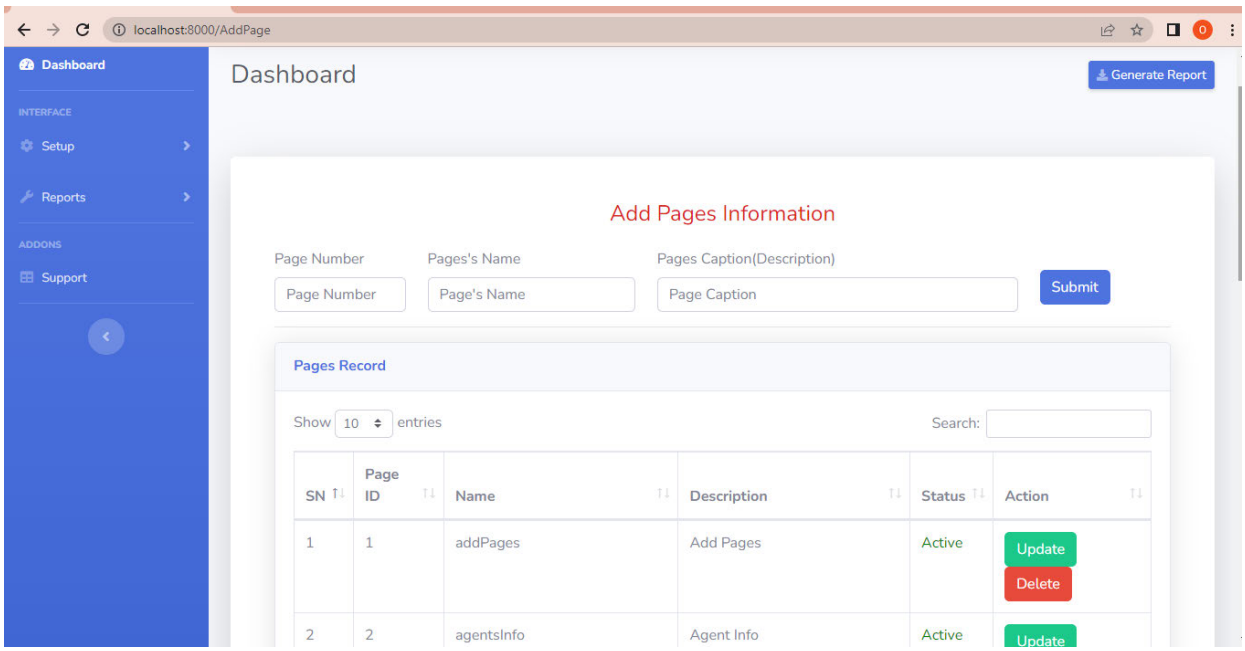


This is the user dashboard for the administrator to manage the contract information and the quotations from the contractors. Here, the administrator will set up the contract information and manage the same as shown above.



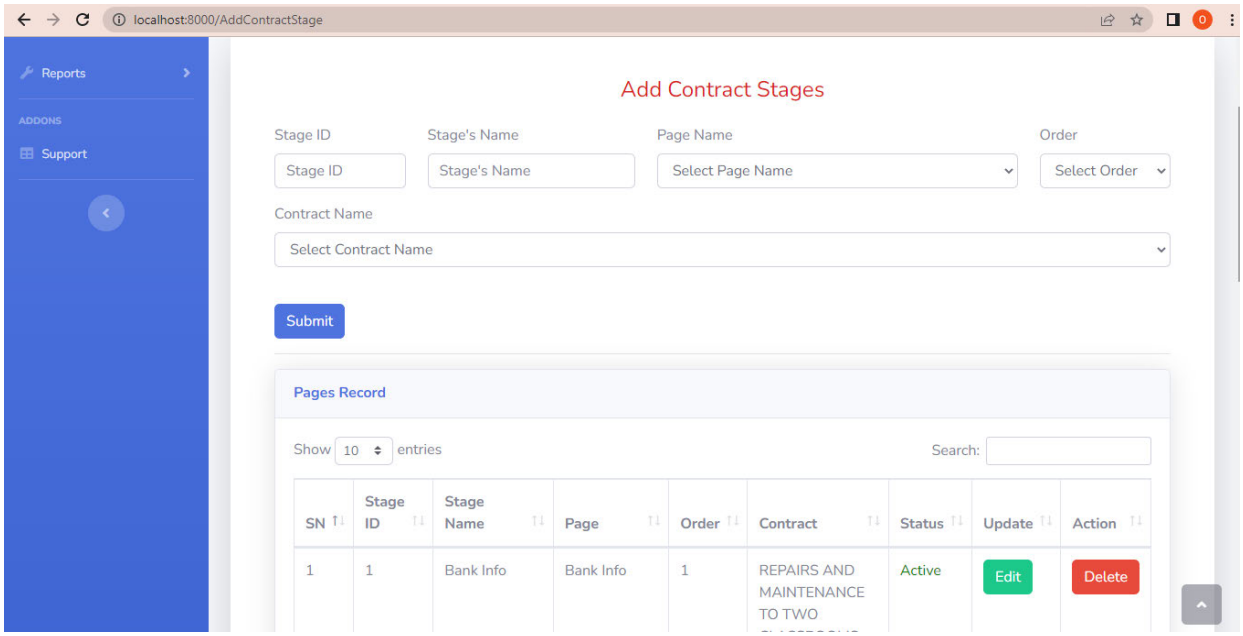
The administrator dashboard consists of pages like add page, add contract pages, contract set up and bidders list.

5.2.3 DASHBOARD - ADD PAGES INFORMATION.

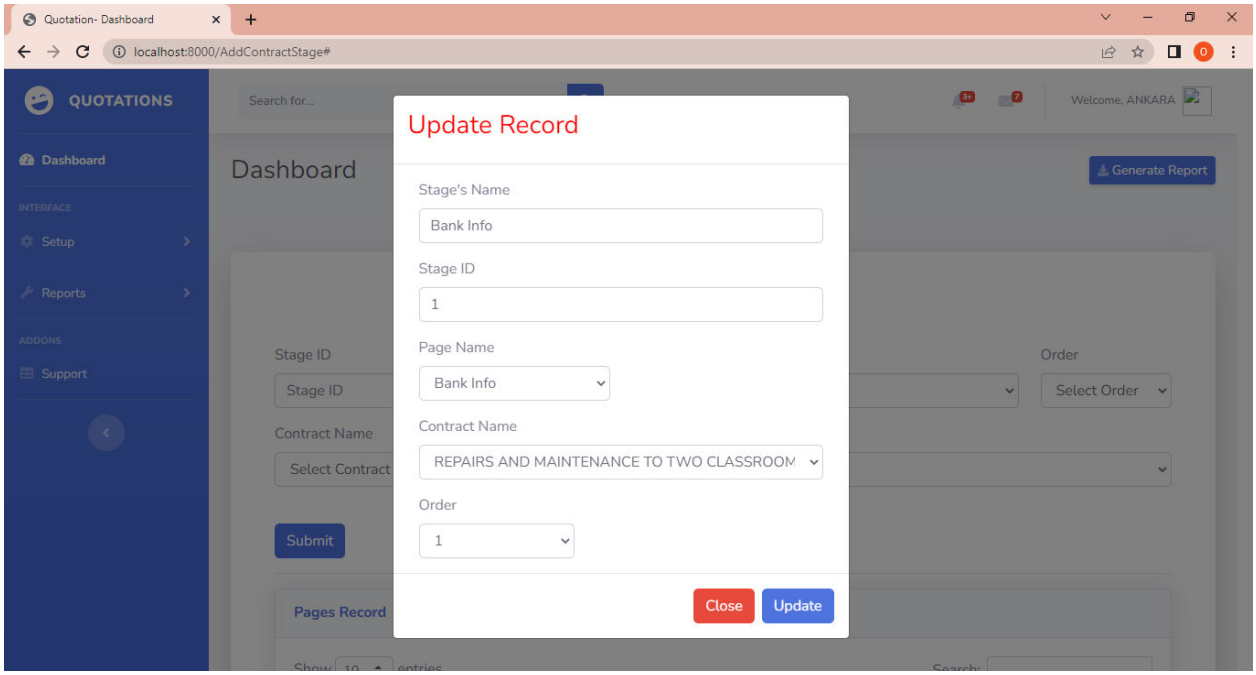


ADD PAGE which manages all other pages within the application. Any new page design within the application will be added by the administrator so that it can be managed and assigned to the appropriate user of the application. The information on this page can be updated, edited, or deleted as needed.

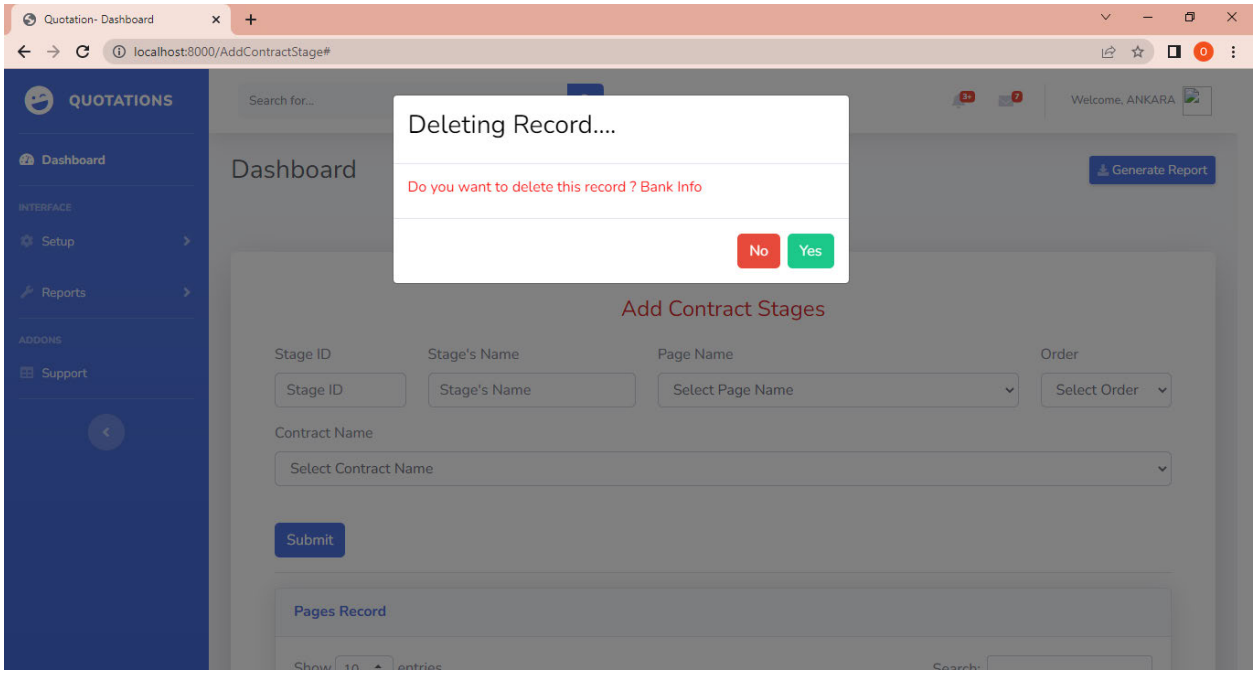
5.2.4. Dashboard- add contract stages.



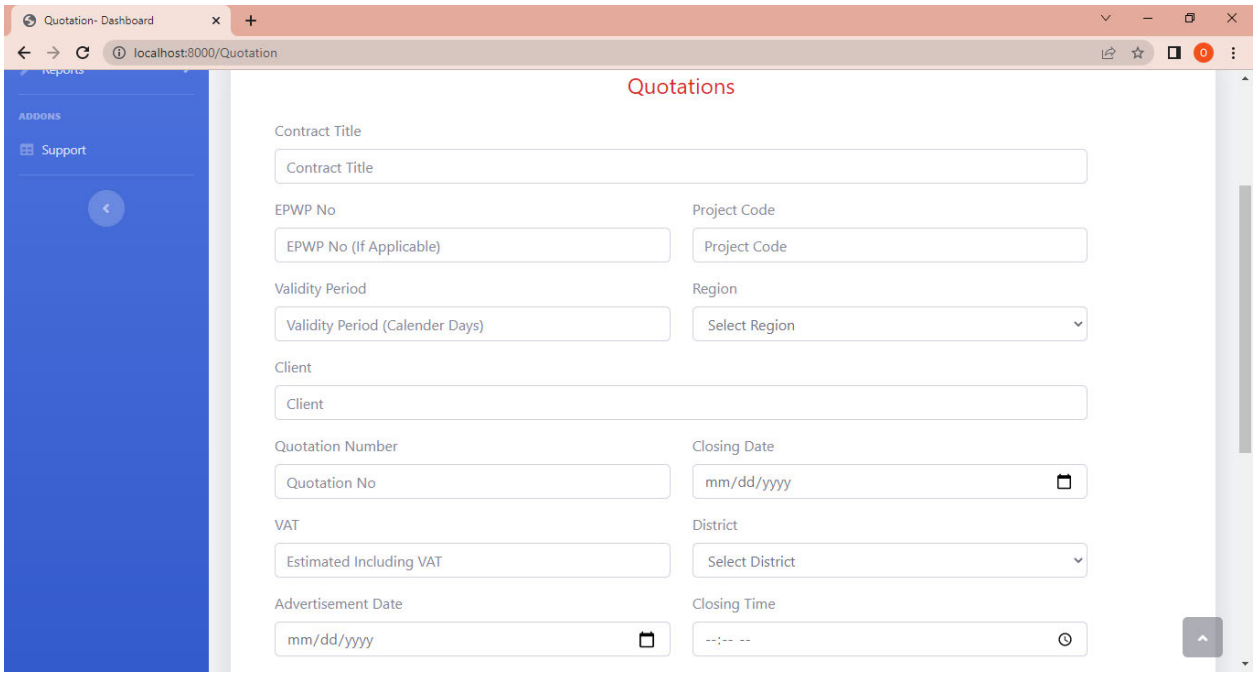
ADD CONTRACT PAGE: This page is managed solely by the administrator and serves as the platform for setting up pages accessible to the users (contractors) for each contract. The information on this page can be updated, edited or deleted as needed.



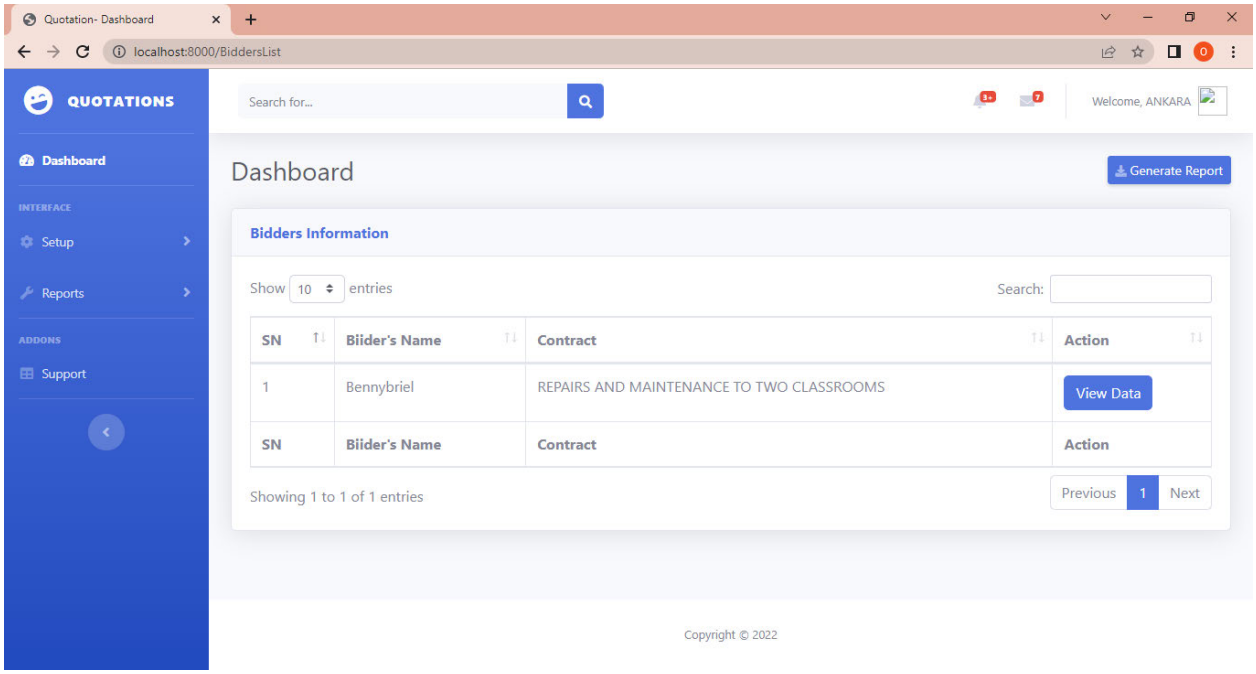
The information on this page can be updated, edited or deleted as needed.



5.2.5. QUOTATIONS PAGE- CONTRACT SET UP.

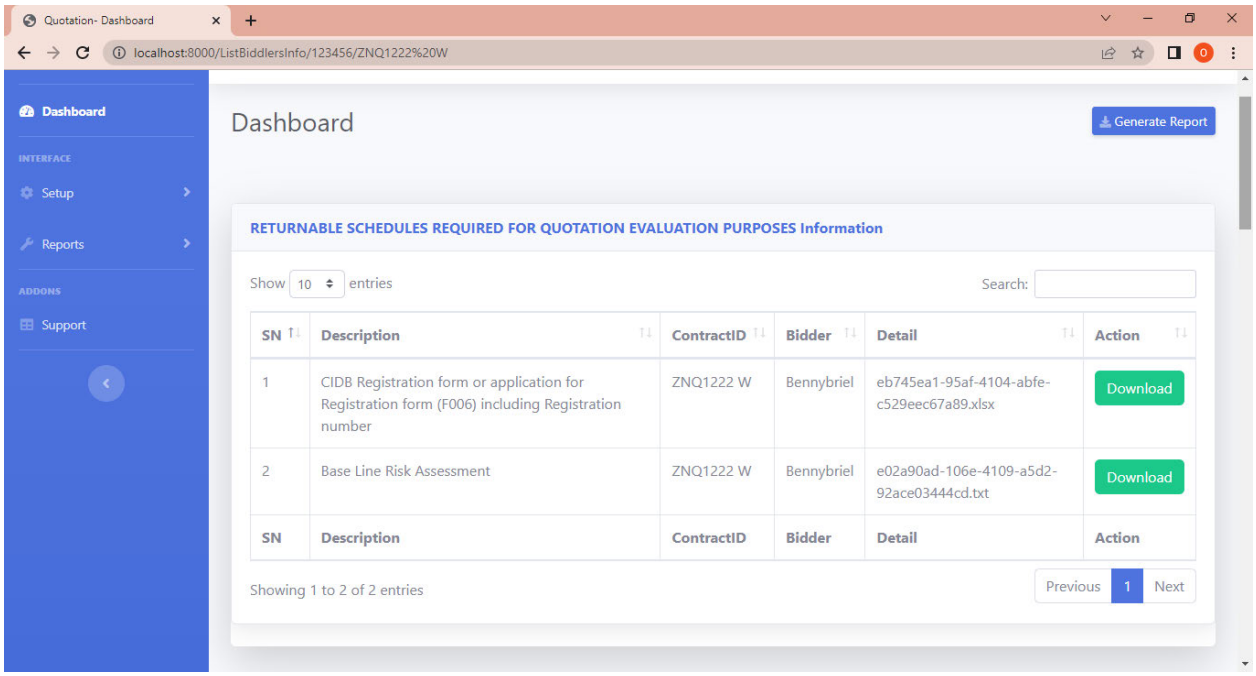


CONTRACT SETUP. The administrator is solely responsible for managing and accessing this page. This page serves as the platform for inputting information about each contract, enabling bidders or contractors to access and utilize it on their dashboard upon logging into their dashboard upon logging into the application.

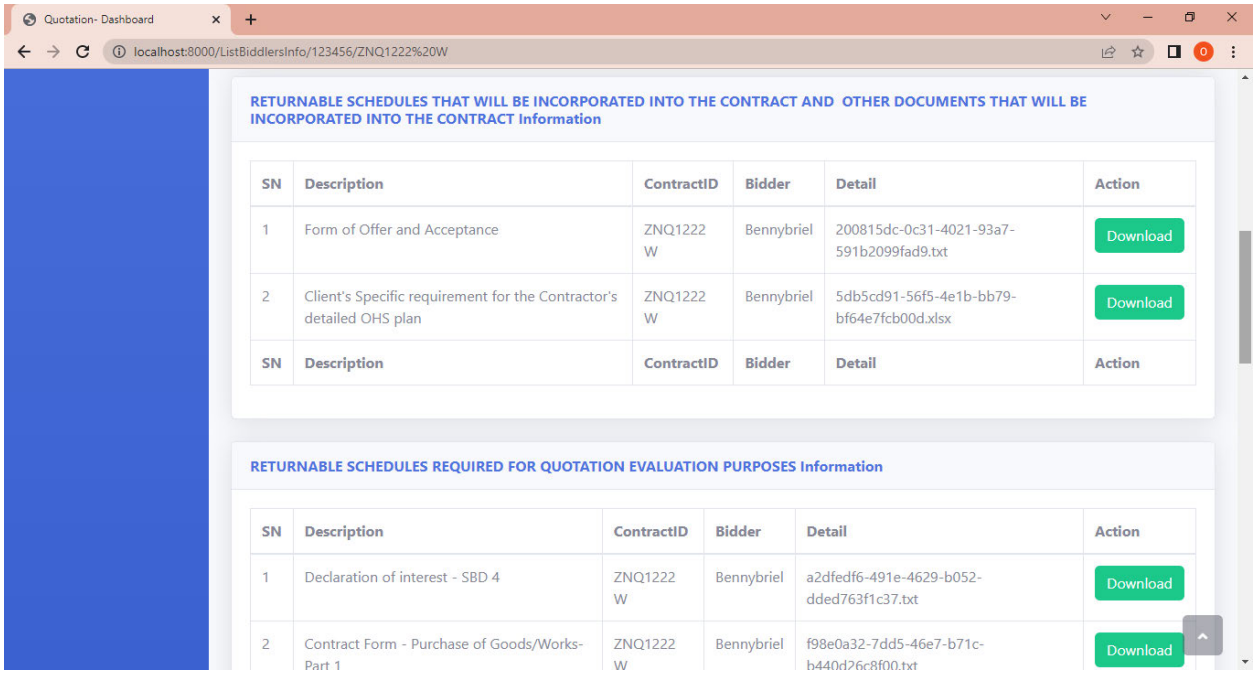


Bidder List: This page is solely managed and accessed by the administrator. This page contains information about all the bidders or contractors who have submitted data about each of the advertised contracts. The administrator is expected to click on the **View Data Button** of each of the bidders to access the full data submitted by each bidder or contractor for a particular contract.

5.2.6. **RETURNABLE SCHEDULES REQUIRED**

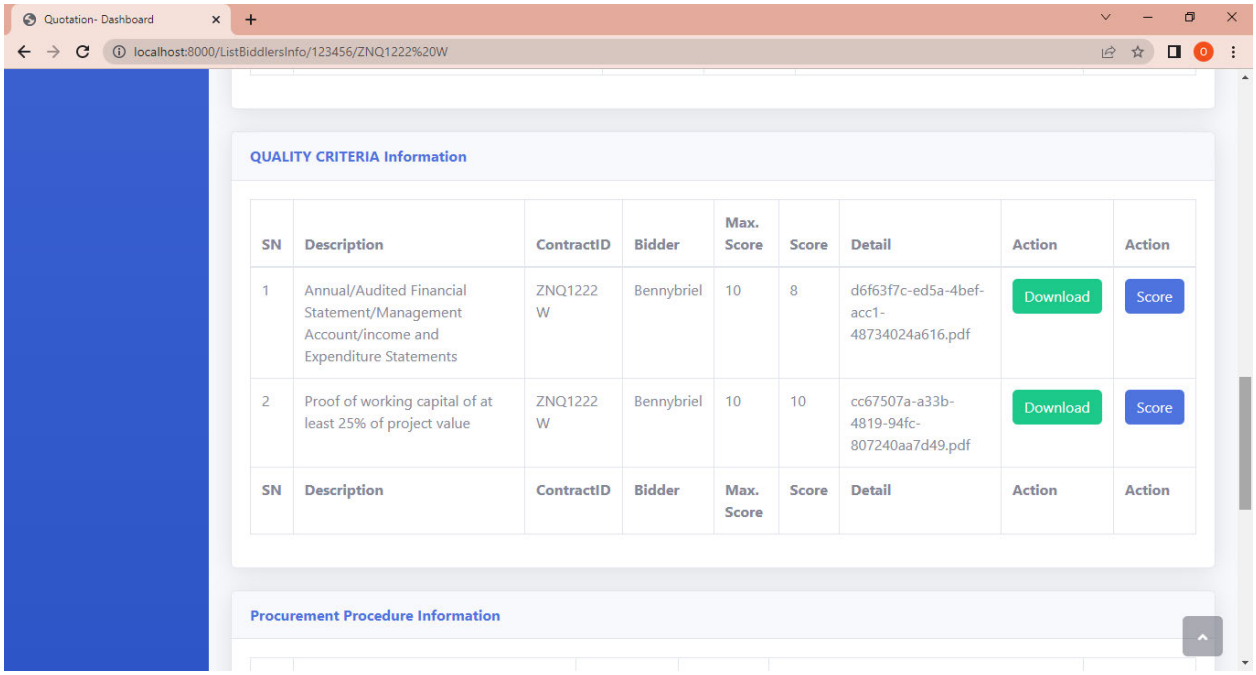


The page above, **RETURNABLE SCHEDULES REQUIRED FOR QUOTATION EVALUATION PURPOSES** contains the data submitted by the bidder for. The administrator is expected to click on the download button to access the data submitted by the bidder.

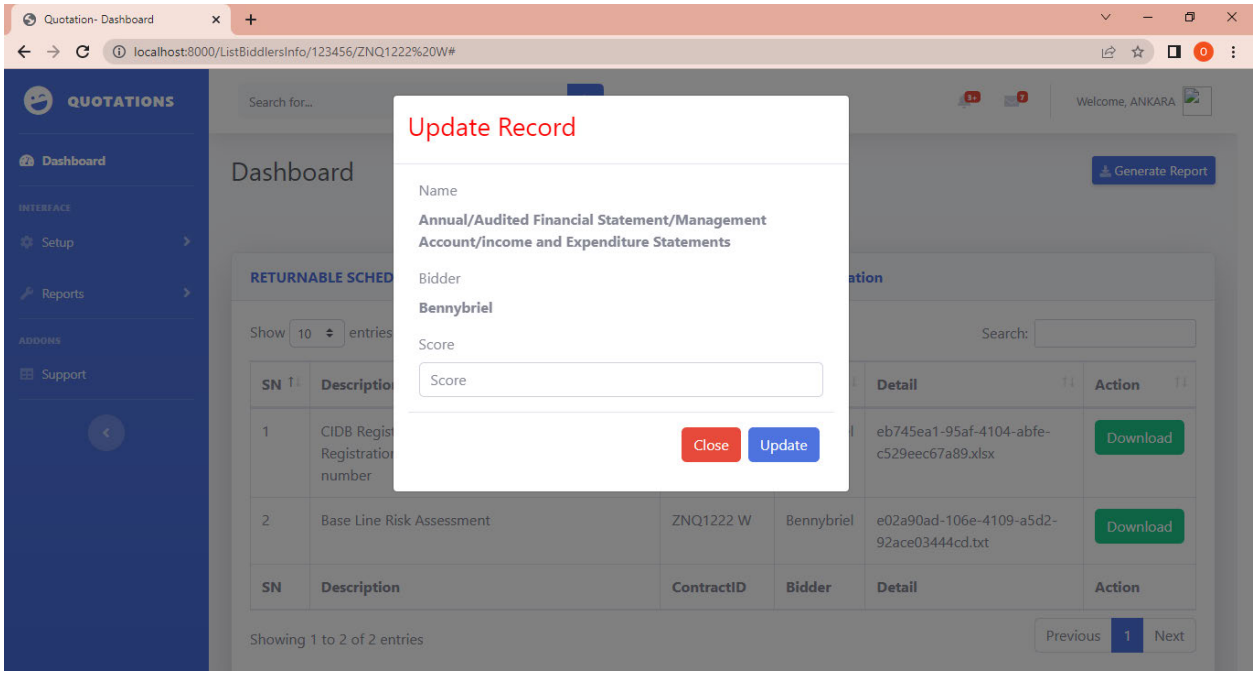


The page, **RETURNABLE SCHEDULES THAT WILL BE INCORPORATED INTO THE CONTRACT AND OTHER DOCUMENTS THAT WILL BE INCORPORATED INTO THE CONTRACT** above contains the data submitted by the bidder. The administrator is expected to click on the download button to access the data submitted by the bidder.

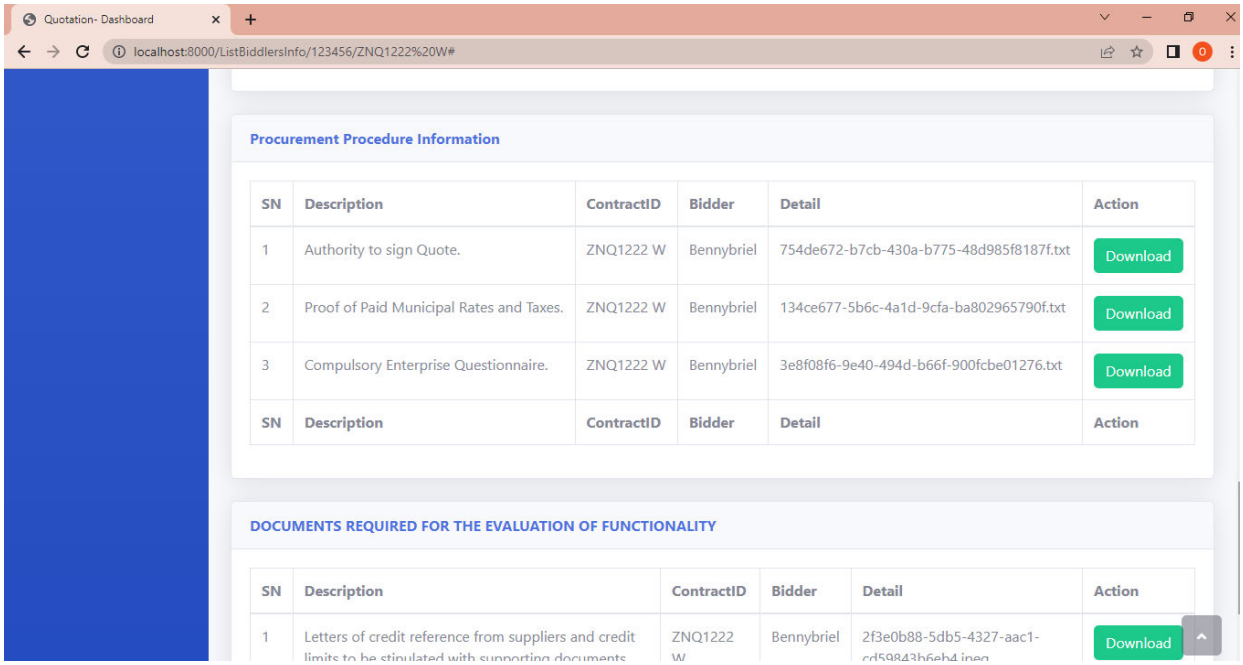
5.2.7. QUALITY CRITERIA



The page above, **QUALITY CRITERIA** contain the data submitted by the bidder. The administrator is expected to click on the download button to access the data submitted by the bidder. After the download, the administrator will then click on score download to enter score for each of the documents accessed.

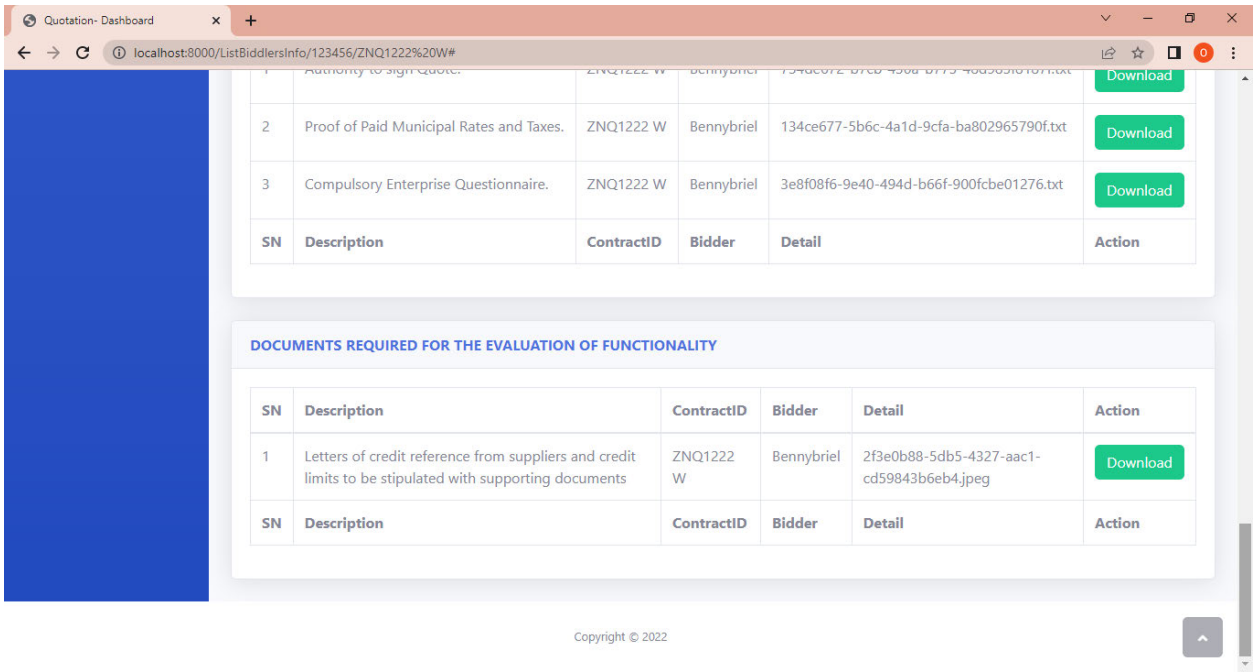


5.2.8. PROCUREMENT PROCEDURES

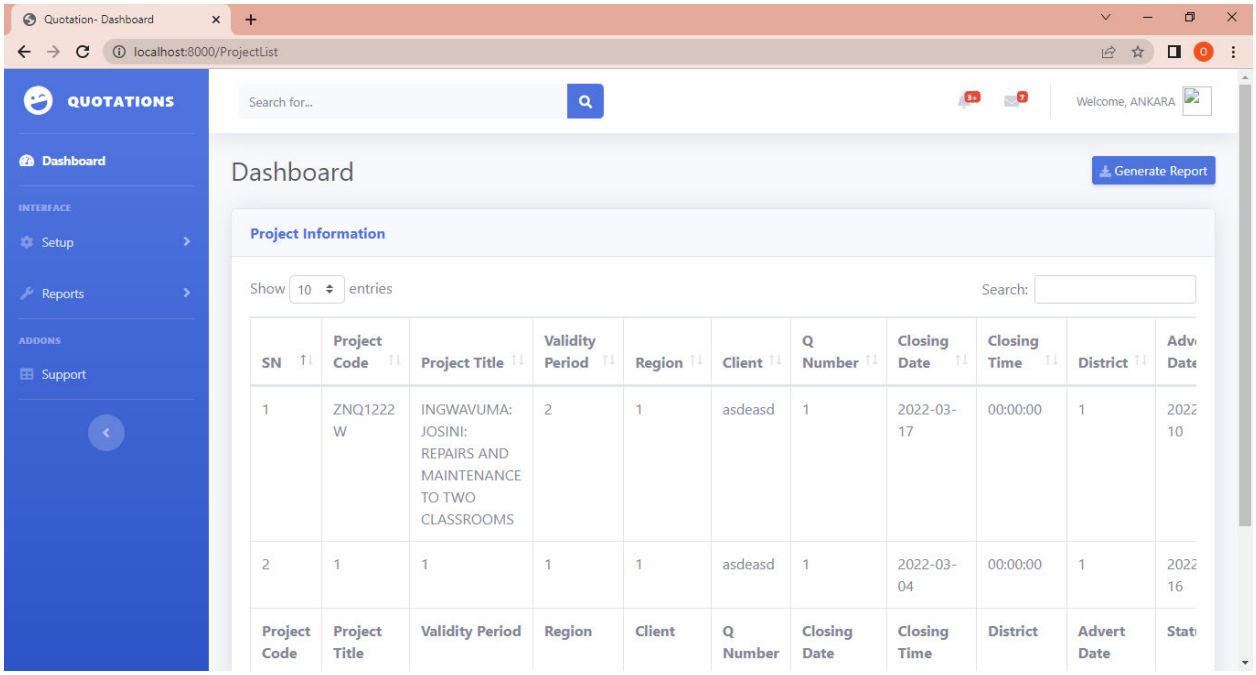


The page, **PROCURMENT PROCEDURE,** above contains the data submitted by the bidder**.** The administrator is expected to click on the download button to access the data submitted by the bidder.

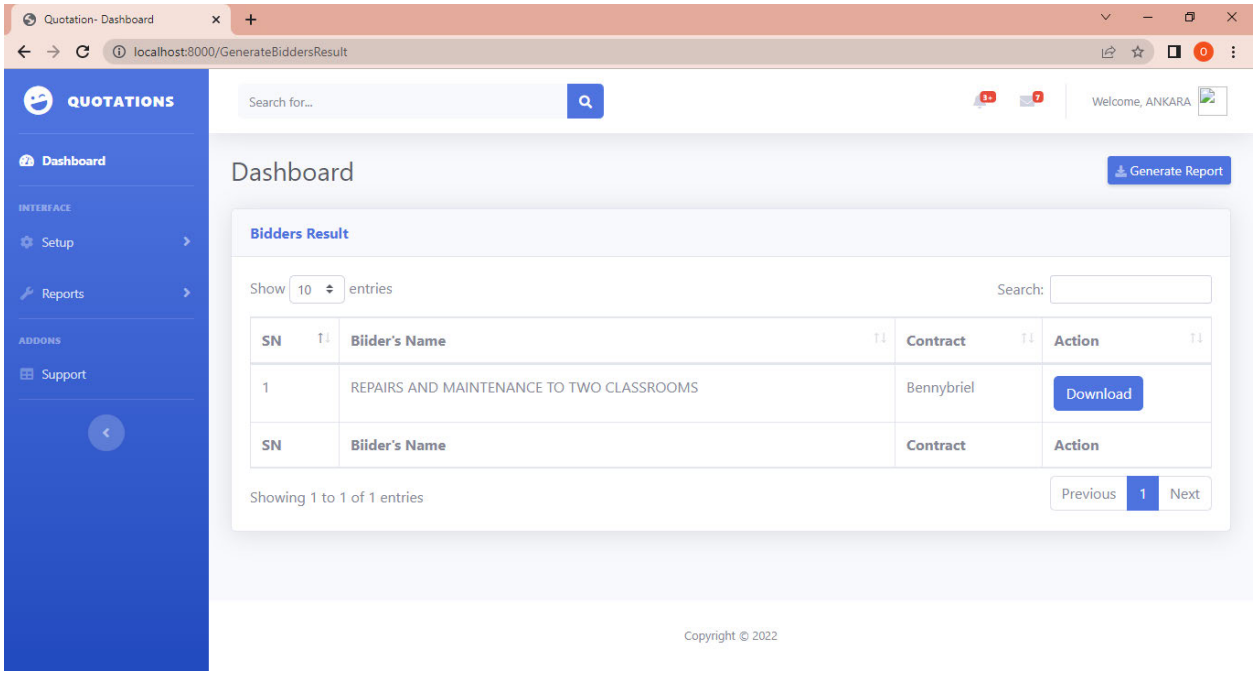
5.2.9. DOCUMENTS FOR EVALUATION FUNCTIONALITY



The page, **DOCUMENTS REQUIRED FOR THE EVALUATION OF FUNCTIONALITY** above contains the data submitted by the bidder. The administrator is expected to click on the download button to access the data submitted by the bidder.

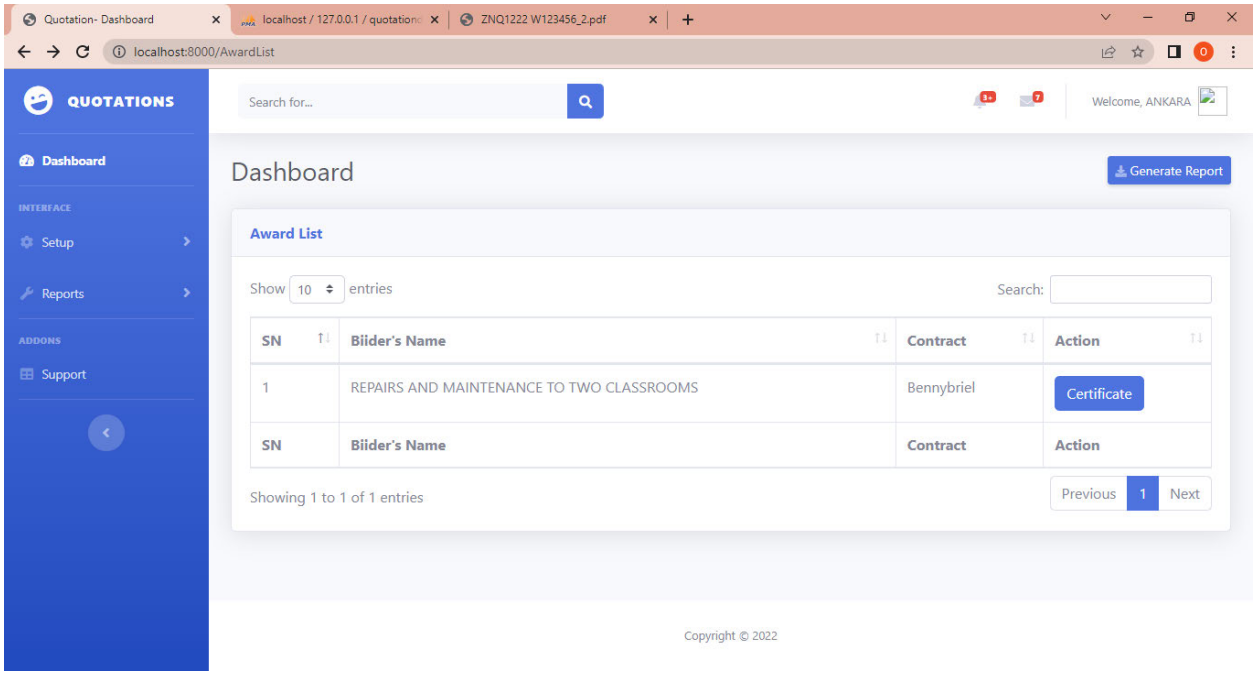


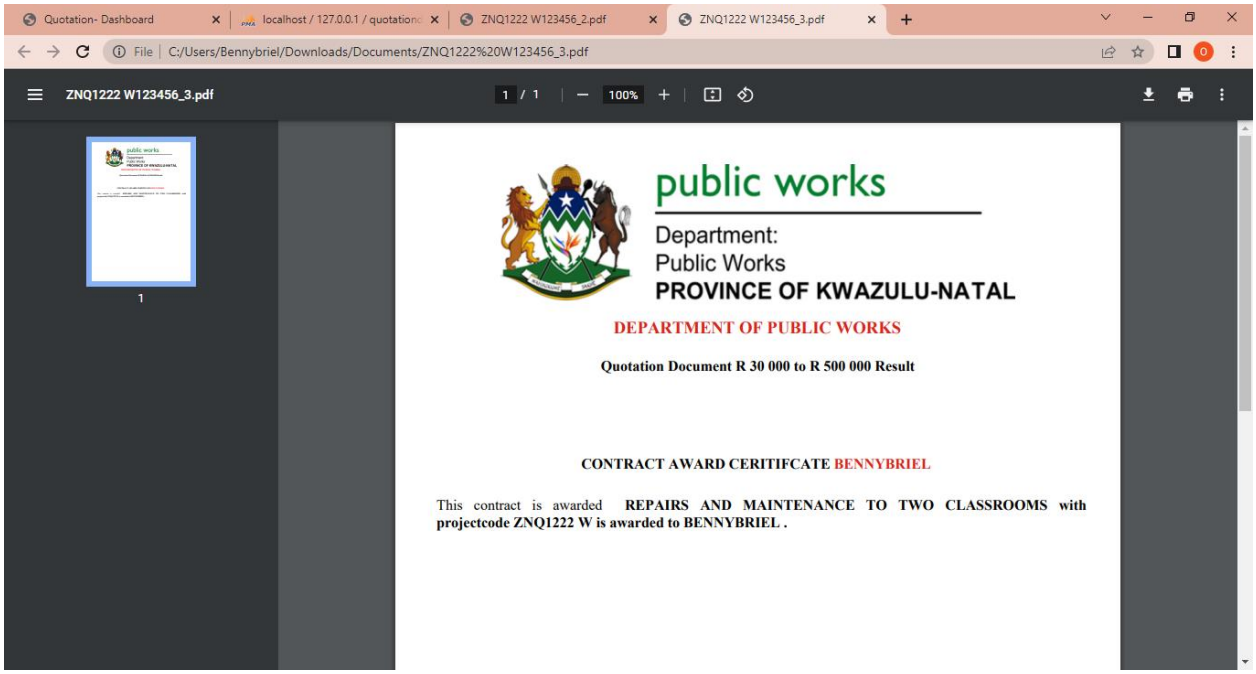
5.2.10. BID RESULTS.



BID RESULTS: After all the information has been uploaded onto the system, the bid evaluation committee is required to participate in the evaluation of the bid using the app. This means that the bid committee can access the app's administrators, or one administrator can project the app and the evaluation can be done collectively. The app can keep records of all the changes that occur and accurate dates of the information uploads, which means that the tracking of the information and presentation processed can be easily accessible in the case of objections.

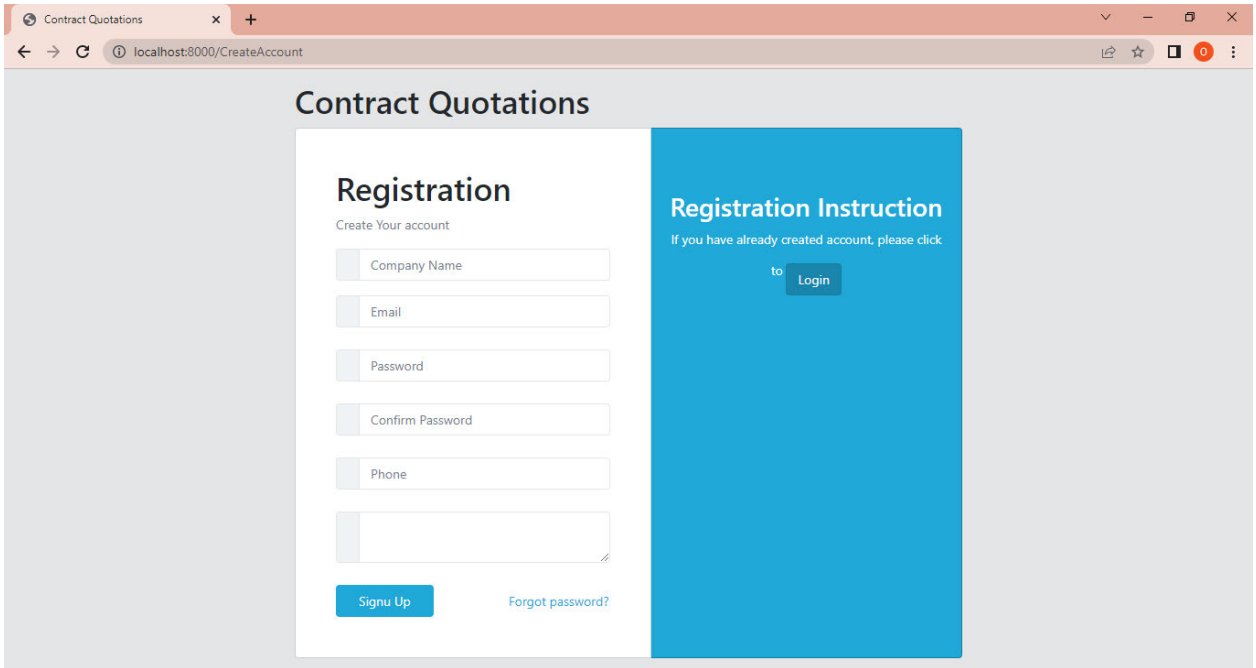
5.2.11. Award list page



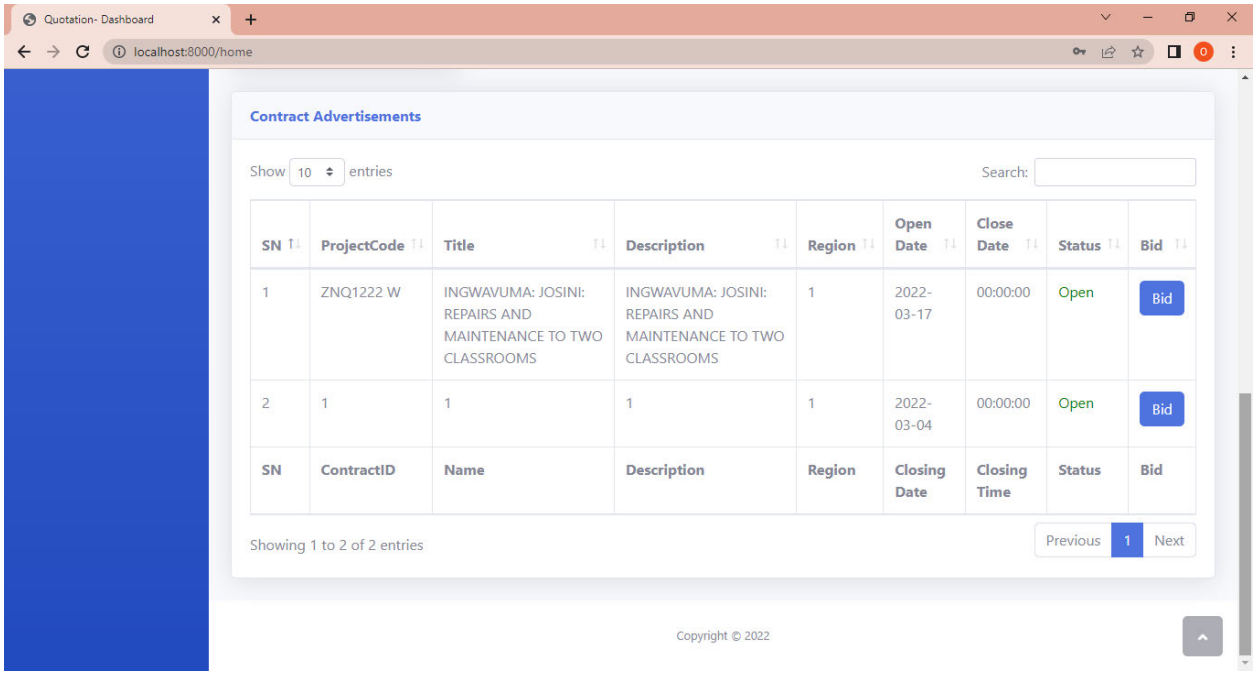


AWARD LIST: After evaluation, the administrator can update the results on this page. Users can view the results on the dates announced on the app, and they can check the results on the app on the same day.

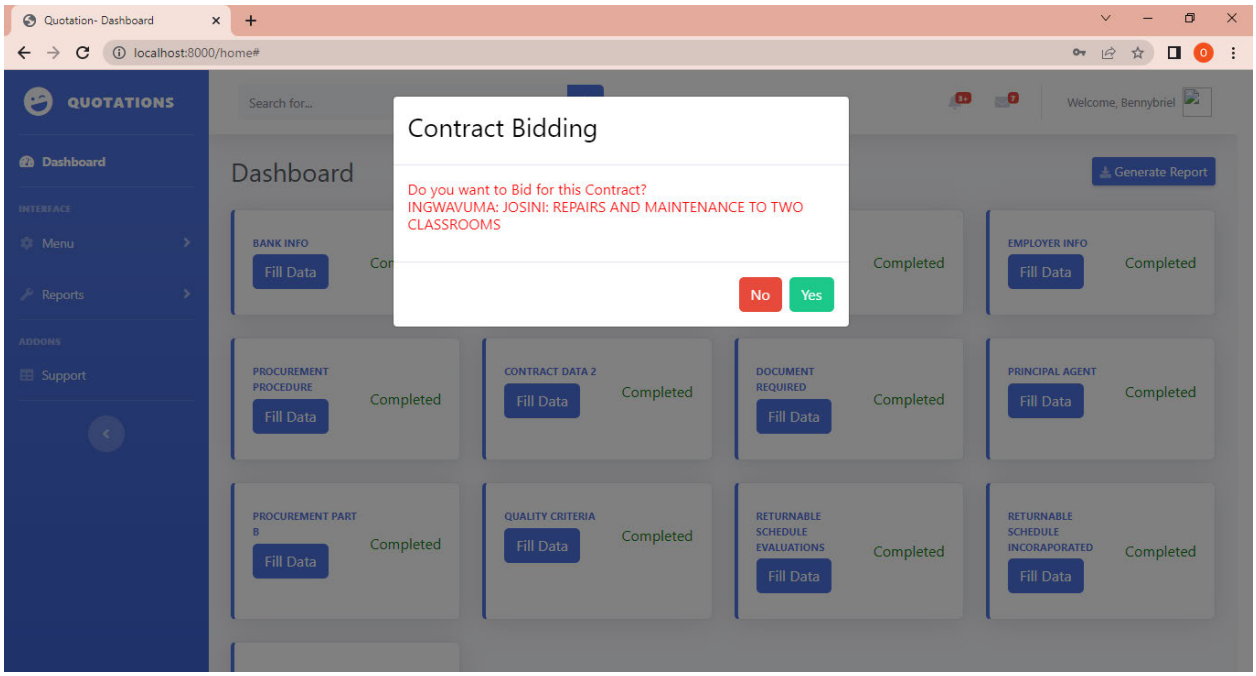
5.2.12. CONTRACTOR REGISTRATION PAGE



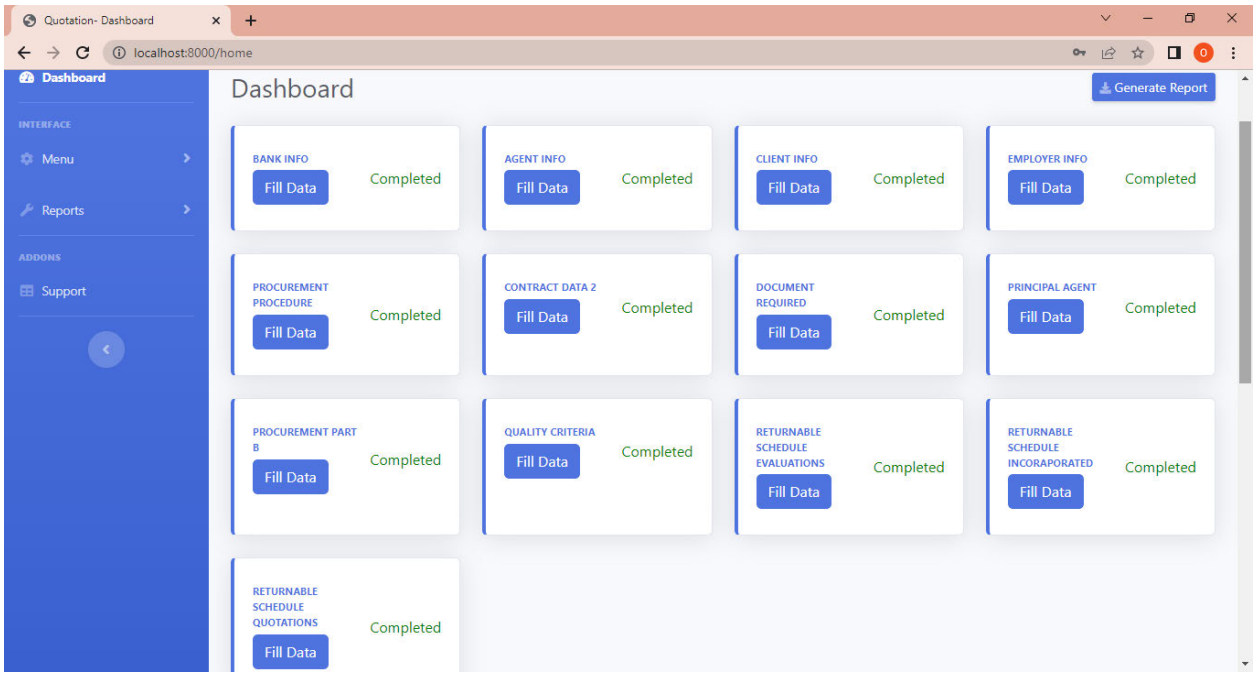
REGISTRATION PAGE: This serves as the gateway for users to register and gain access to the application. All prospective bidders or contractors are required to complete registration here.



Bidder's or contractor dashboard: This is the page that the bidder/contractor will use to bid for the contract. The contractor will click on the Bid button, and a page will pop up to confirm whether the bidder wants to bid for the contract or not, as displayed below.



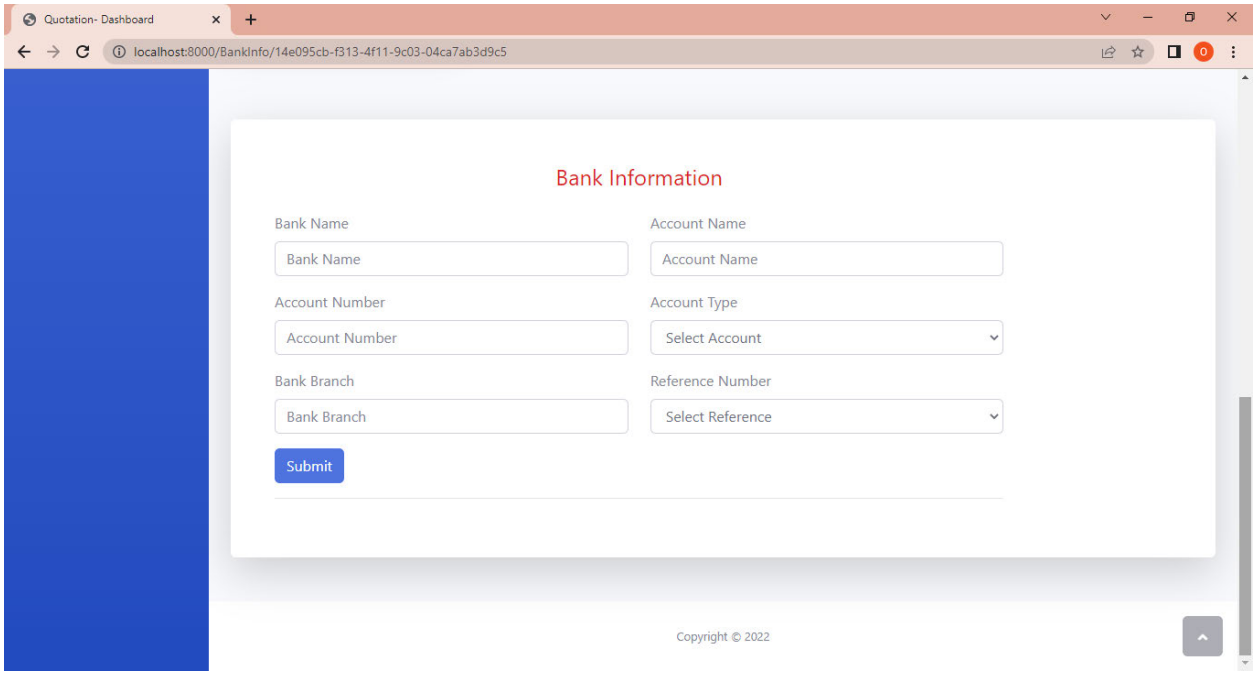
When the contractor/bidder clicks on the YES option, the page below is displayed for the contractor to start in the required information.



BIDDER'S OR CONTRACTOR DASHBOARD: This is the home page for each bidder.

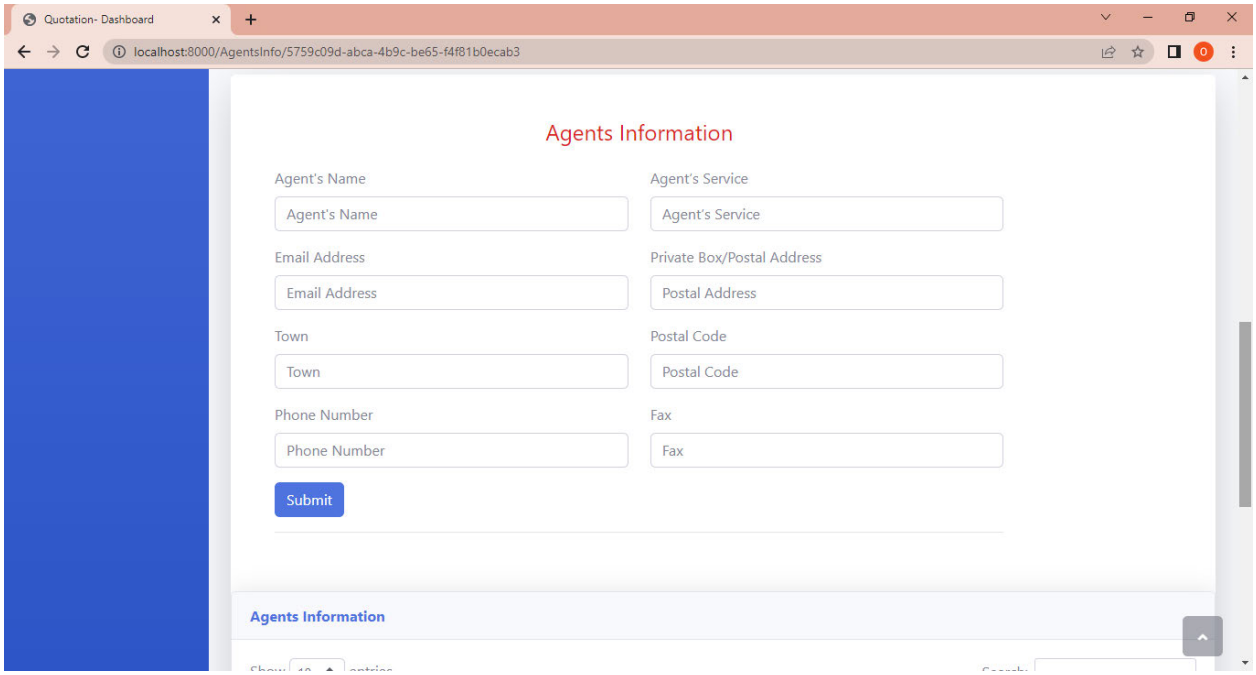
This page consists of all the pages expected to be accessed for specific contract- related information as set up by the application administrator. Each bidder/contractor is expected to click on the Fill Data button. The page to be filled out will display below, and the bidder will have to scroll down to gain full access to the page. When the bidder completes filling out each of the above pages, the status changes from pending to completed with a green color

5.2.13. Bank information page

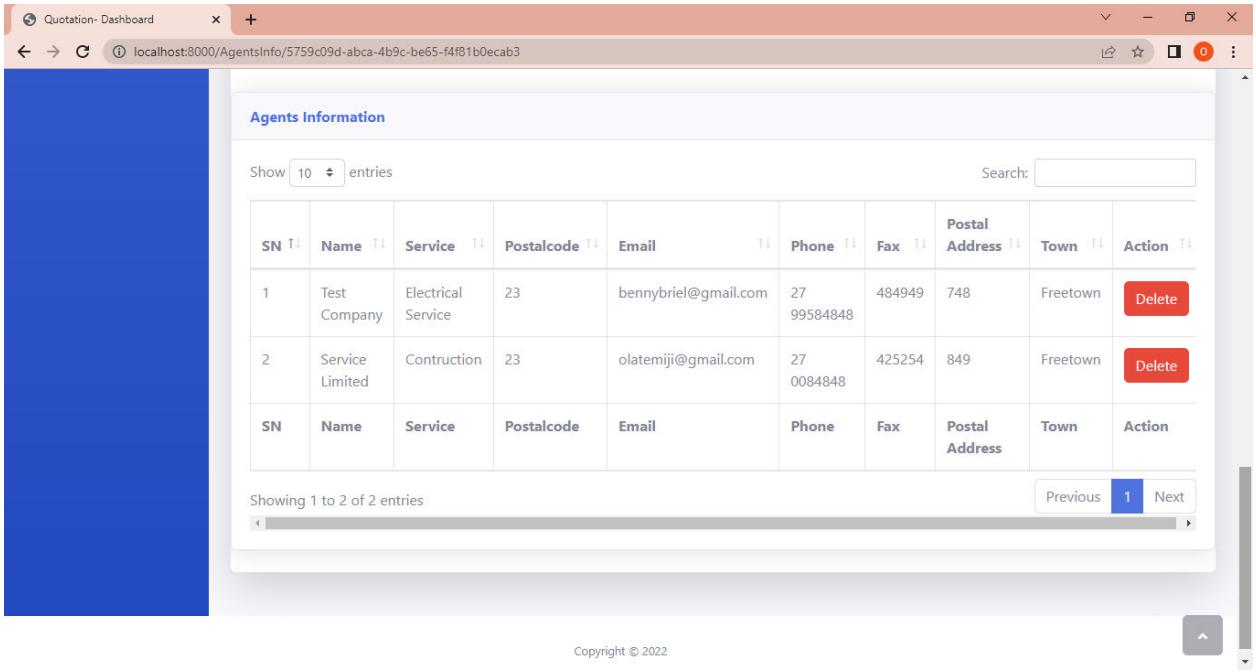


BANK INFORMATION PAGE: This page request for bank information.

5.2.14. AGENT INFORMATION PAGE

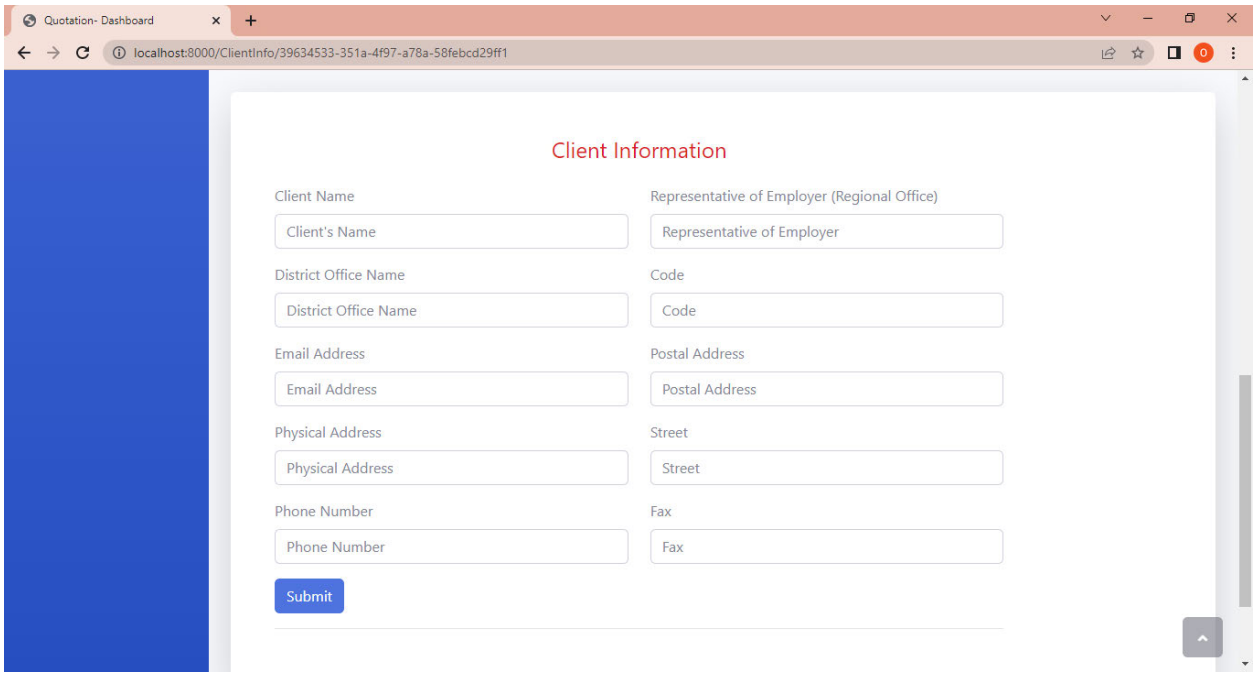


AGENT INFORMATION PAGE: This page requests the bidder's information.



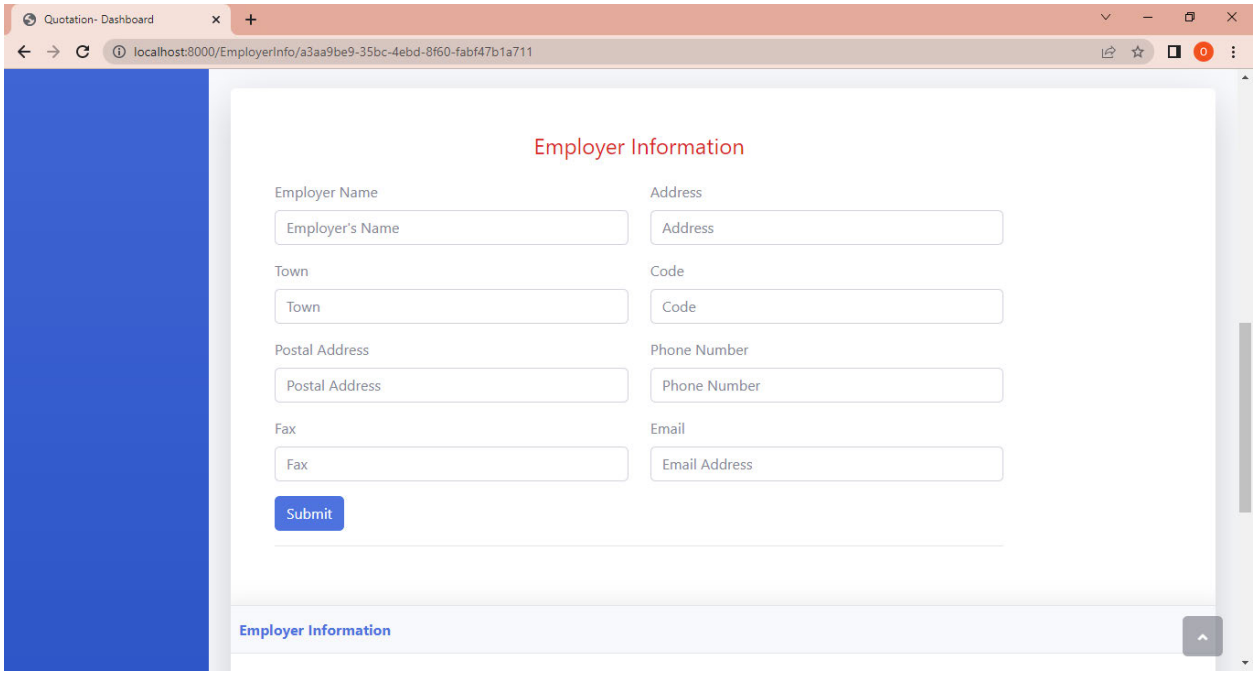
This is the list of agents for each of the bidders.

5.2.15. CLIENT INFORMATION PAGE

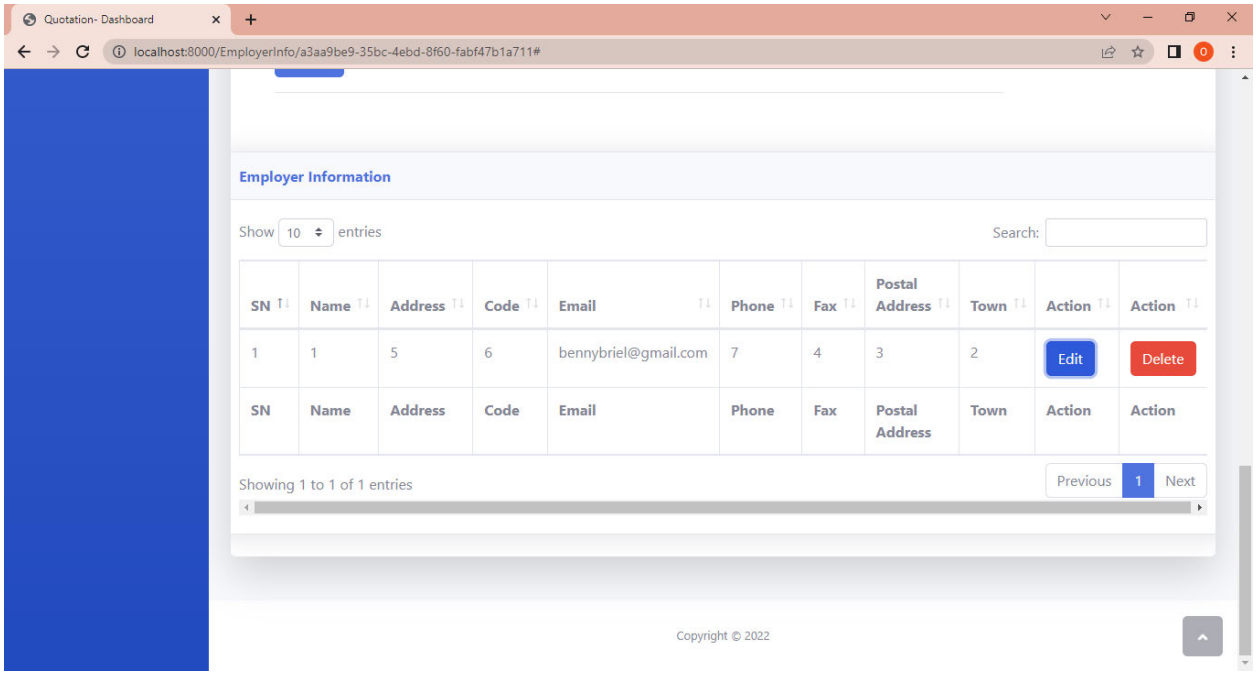


CLIENT INFORMATION PAGE: This page requests the bidder's client information.

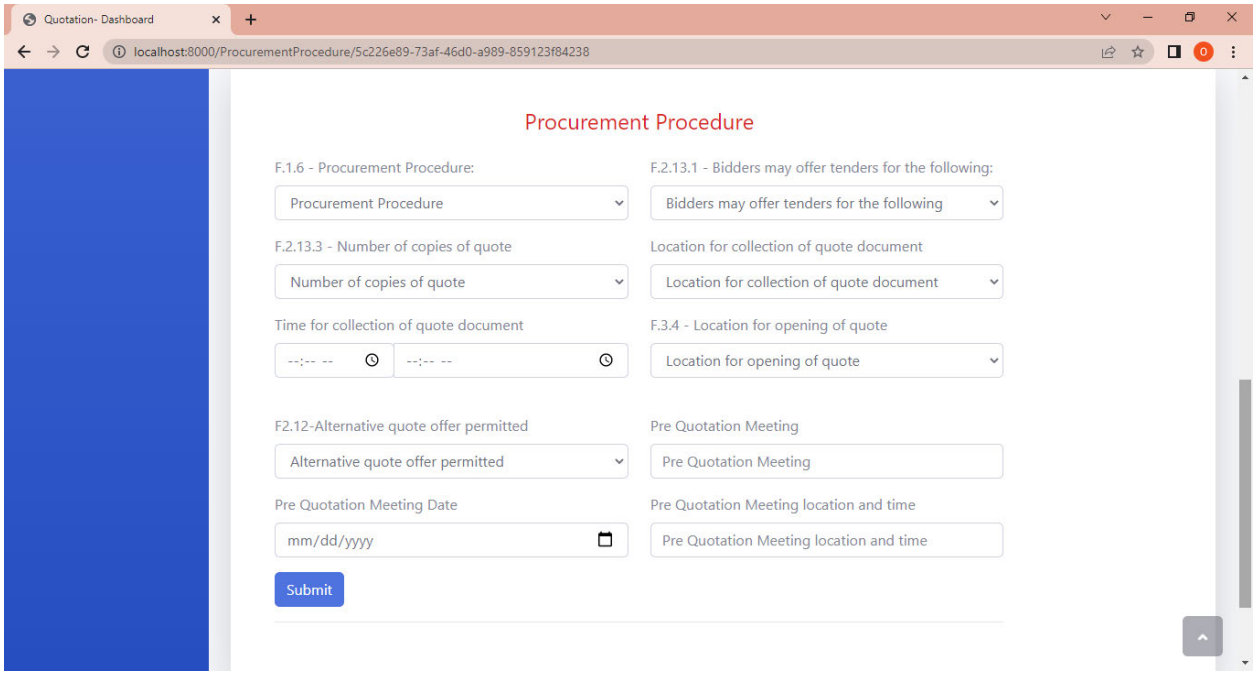
5.2.16. EMPLOYER INFORMATION PAGE



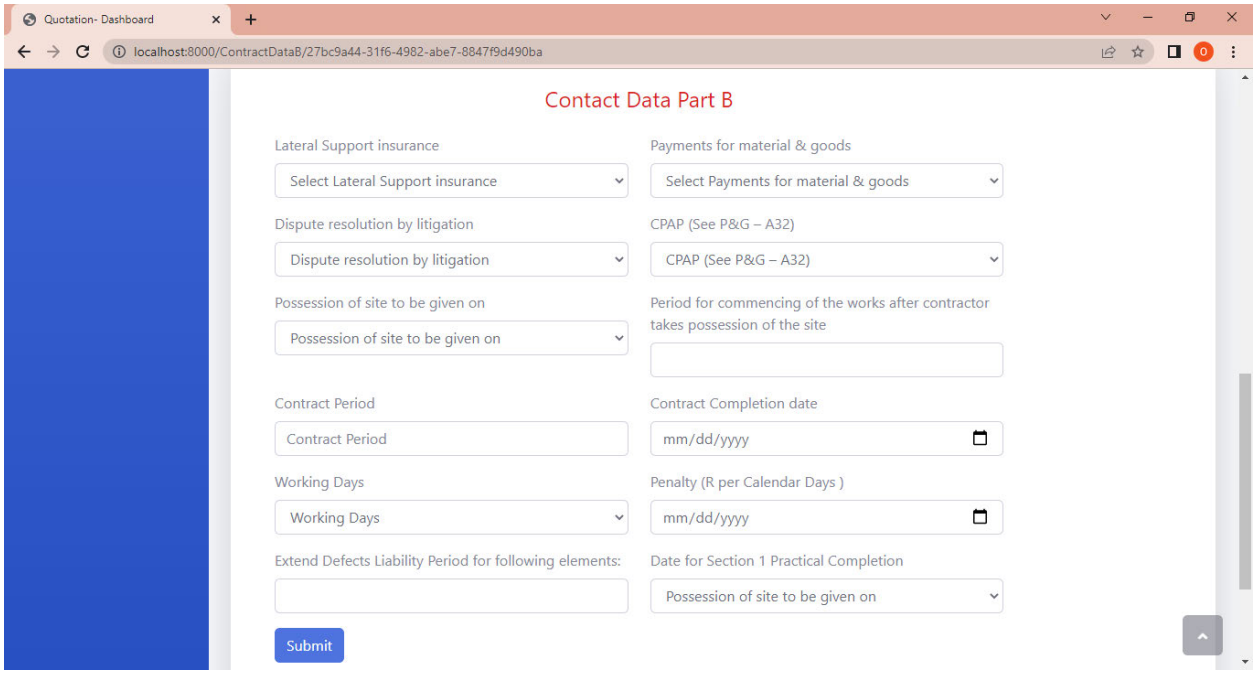
EMPLOYER INFORMATION PAGE: This page requests the bidder's employer information.



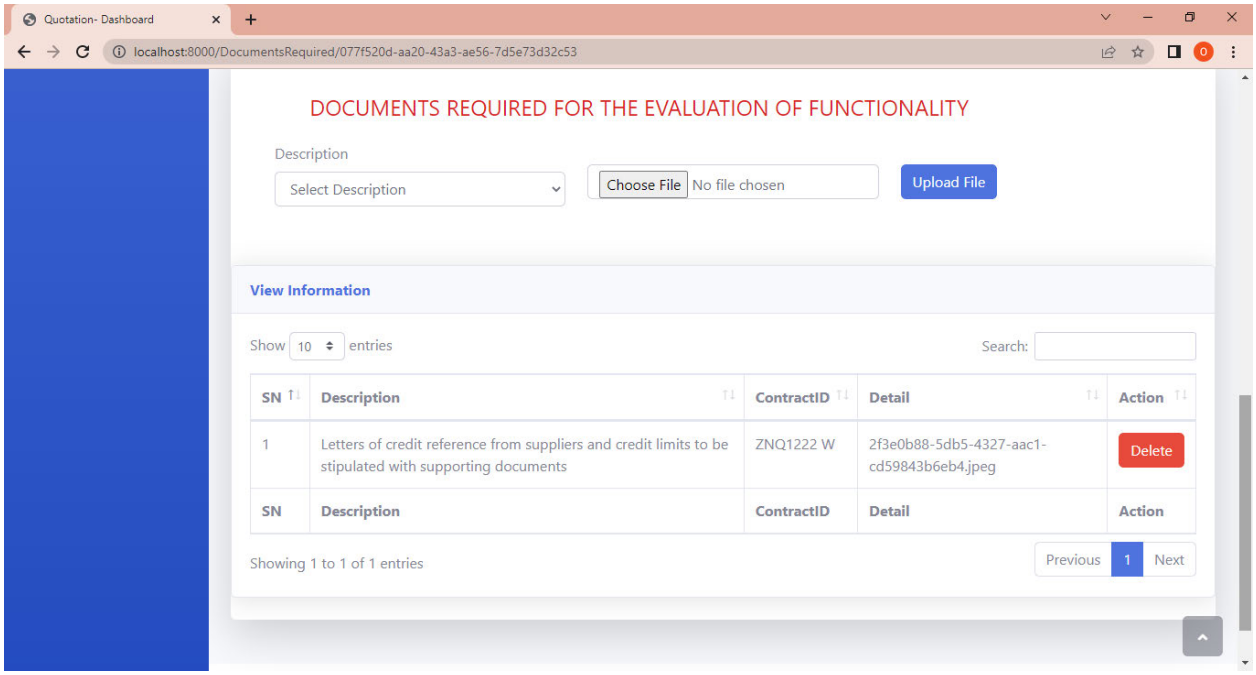
5.2.17. PROCUREMENT PROCEDURE PAGE



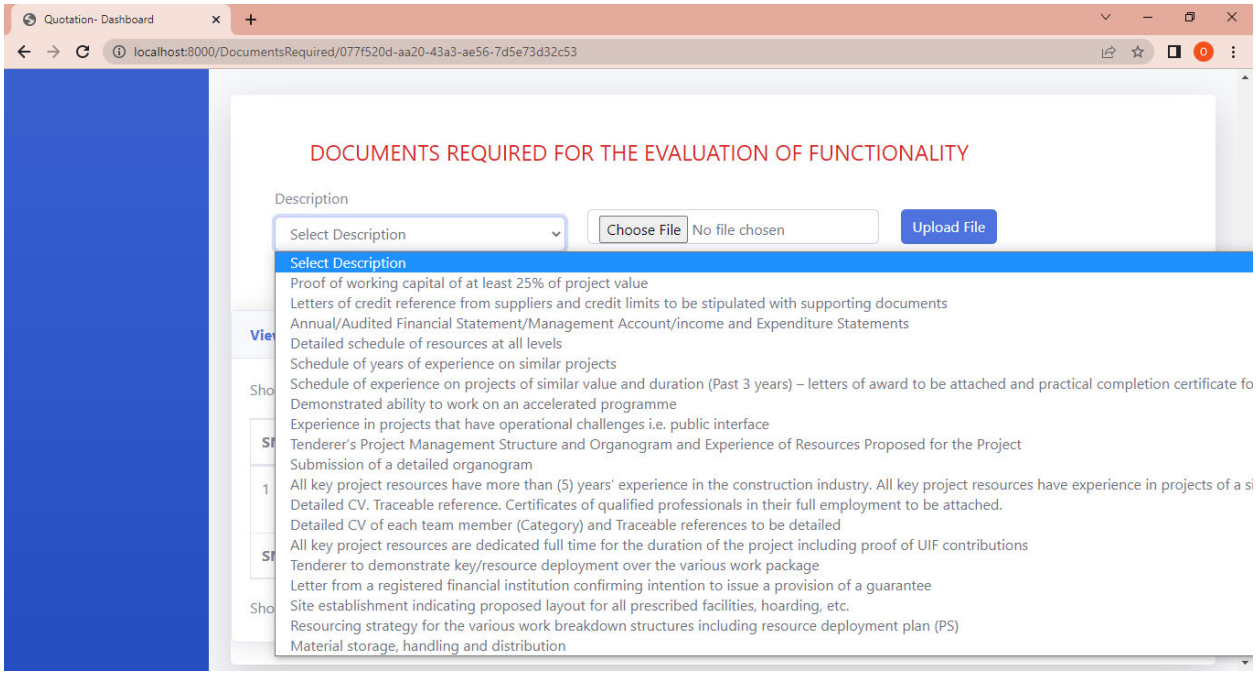
PROCUREMENT PROCEDURE PAGE: This page request the bidder's procurement procedure.

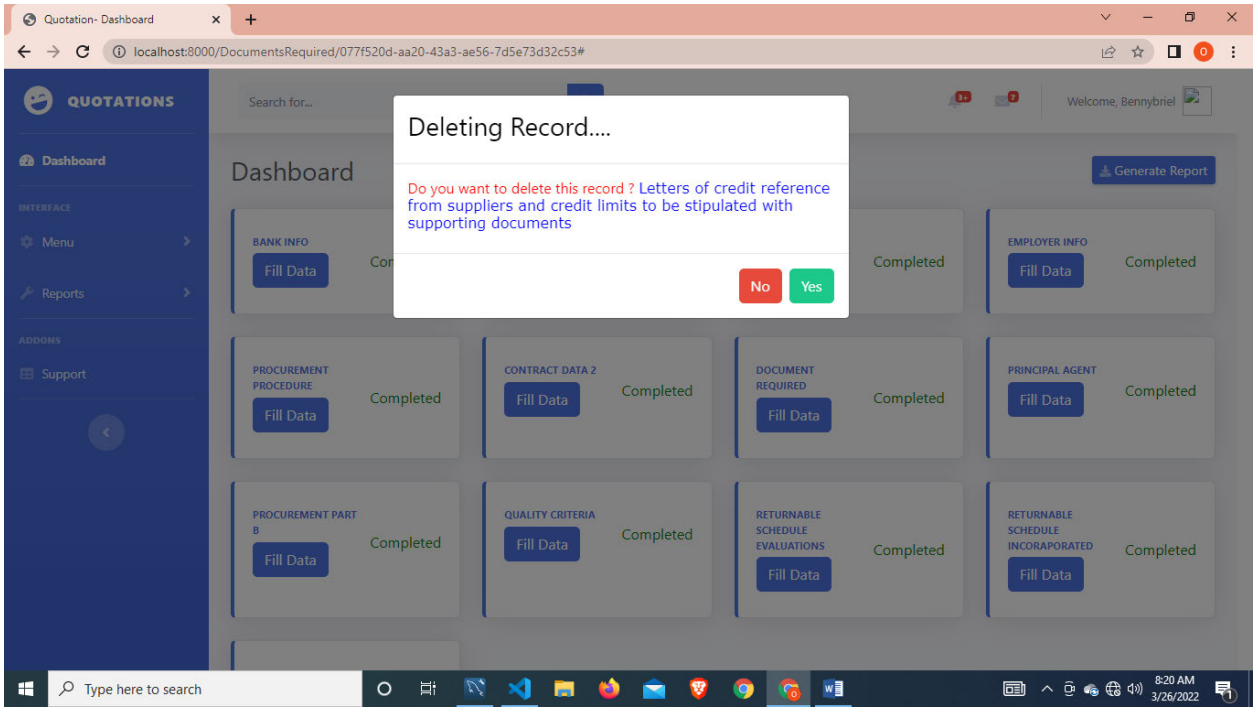


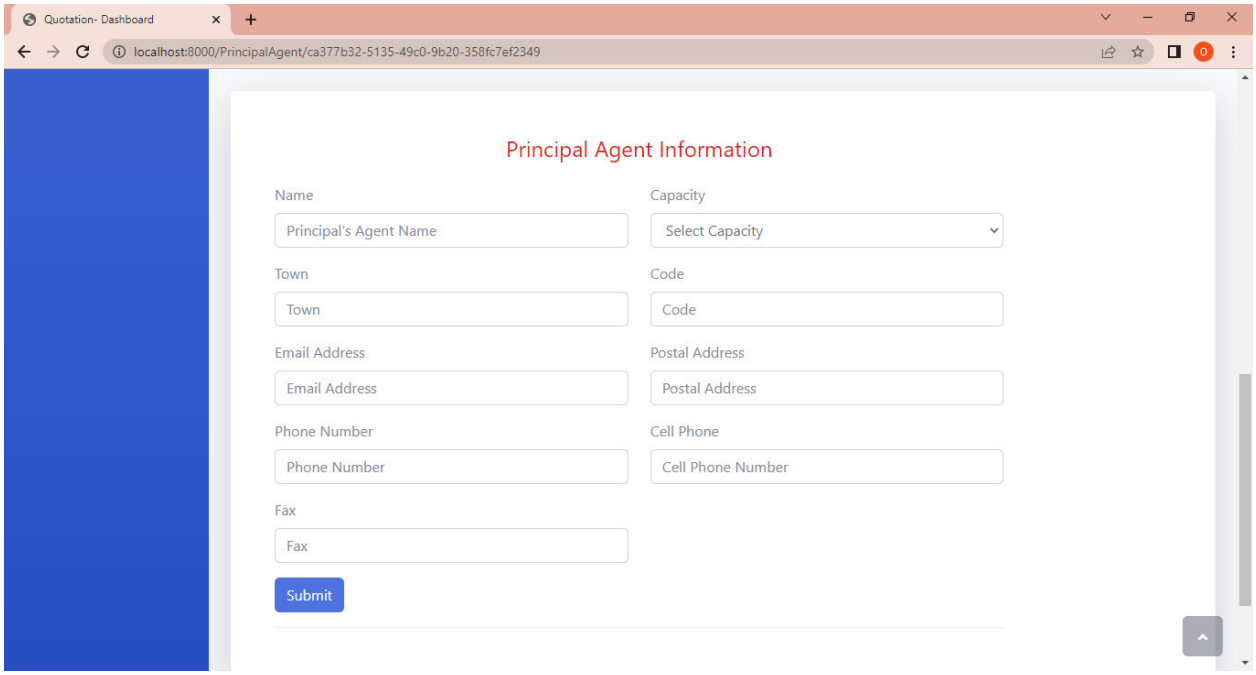
5.2.18. DOCUMENTS REQUIRED FOR EVALUATION



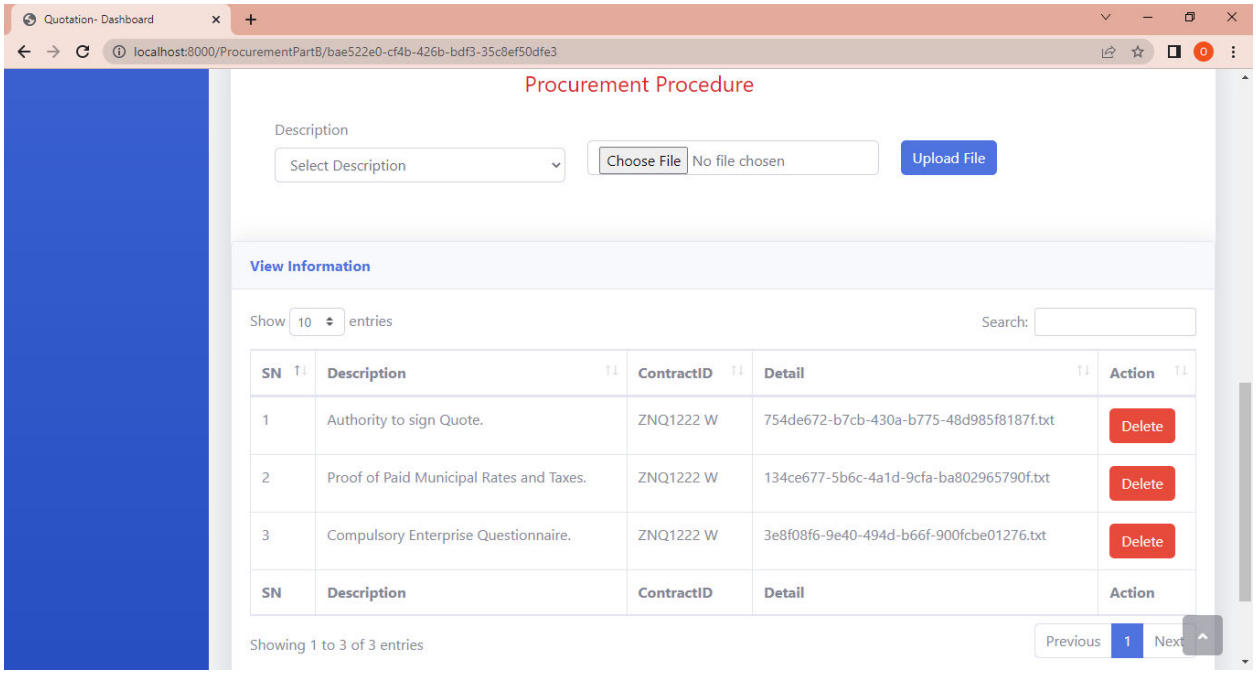
DOCUMENTS REQUIRED: This page requests the bidder's document required information. The bidder is expected to select a description and upload an appropriate file for the description selected in PDF format. Bidders/contractors can also delete any file wrong submitted.



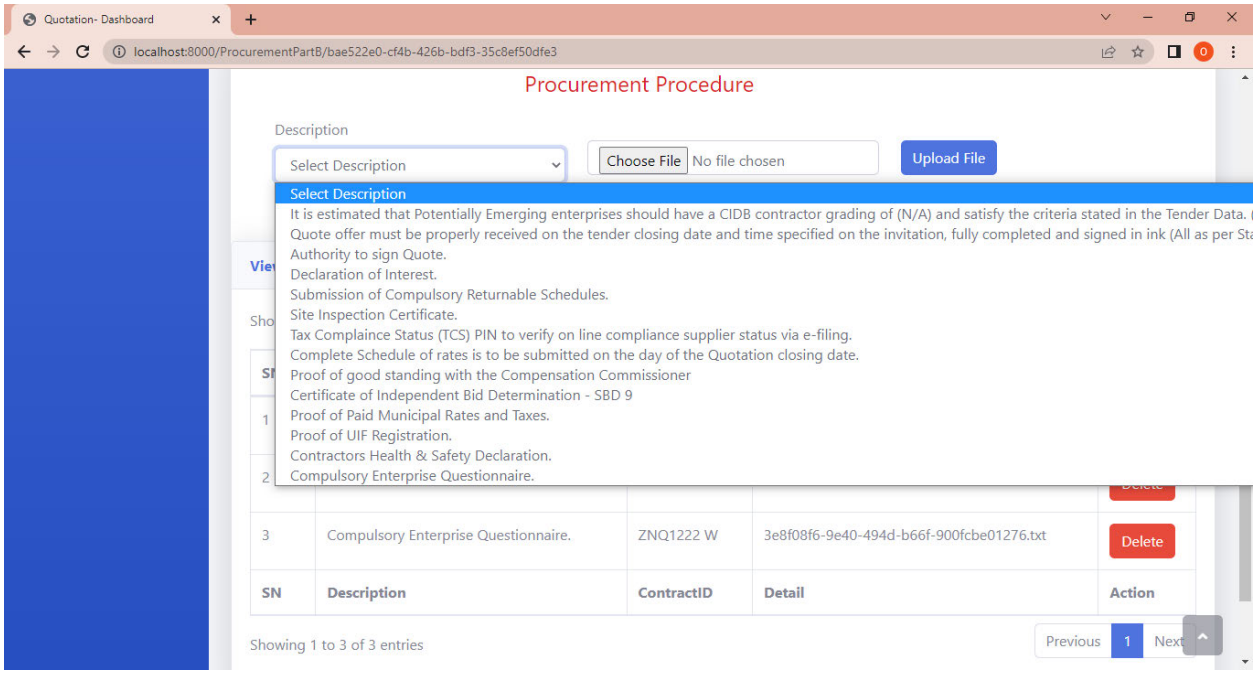




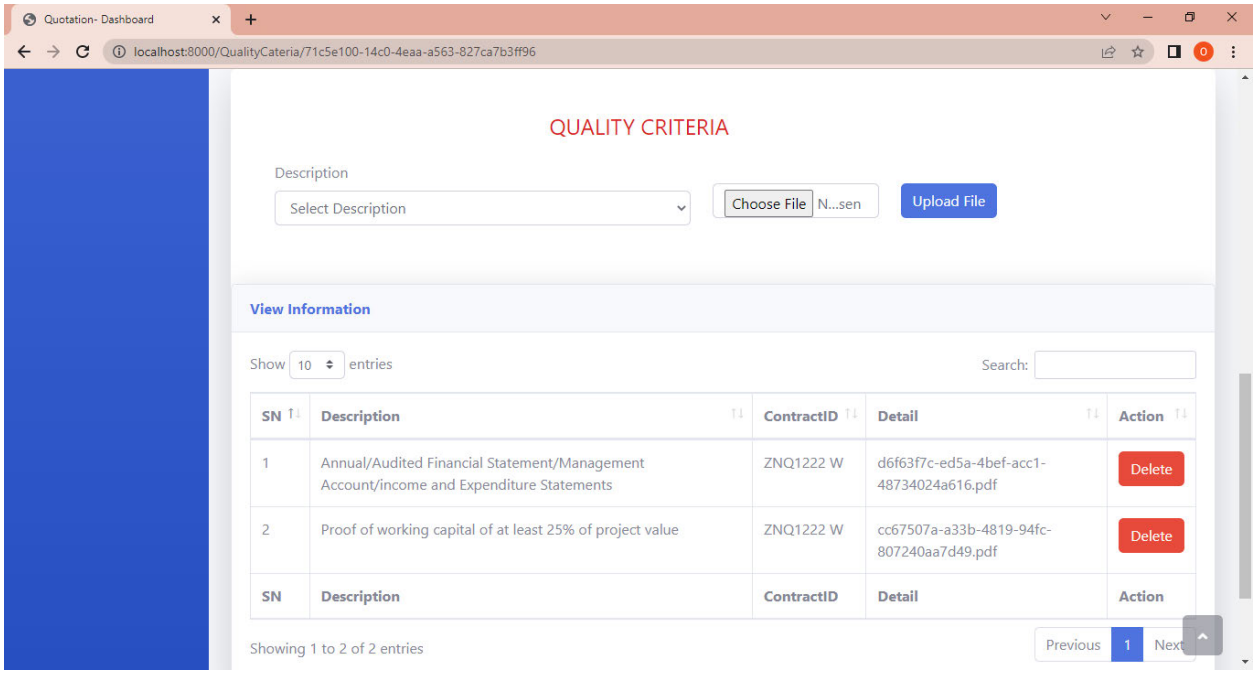
PRINCIPAL AGENT PAGE: This page is for the bidder's principal agent.



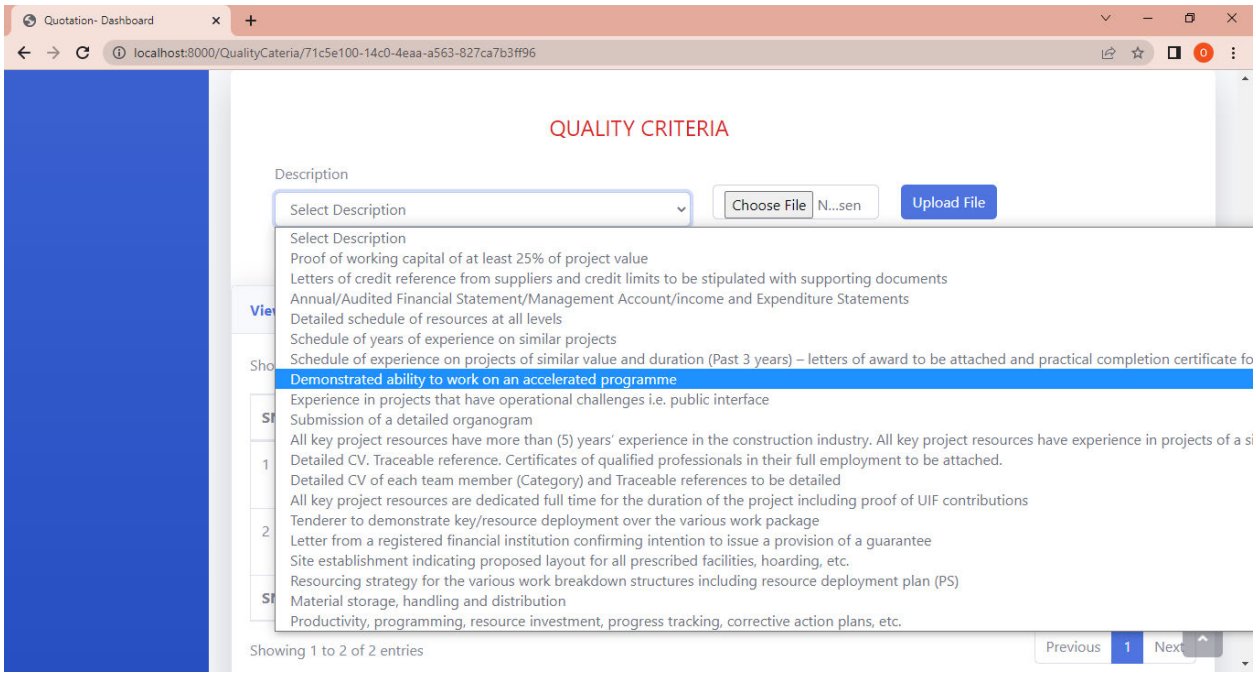
PROCUREMENT PROCEDURE: This page is for procurement procedure information of the bidder. The bidder is expected to select a description and upload an appropriate file for the description selected. The format of the file upload should be in PDF. Bidders/contractors can also delete any file wrong submitted.



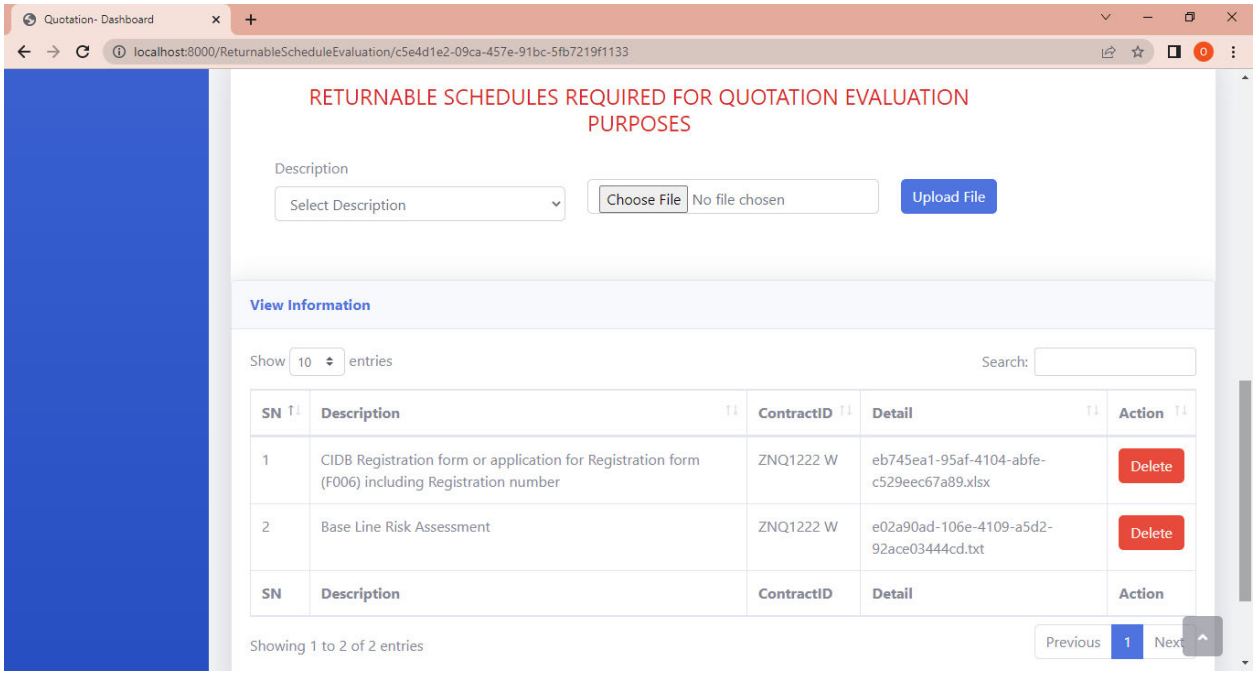
5.2.19. Quality Criteria



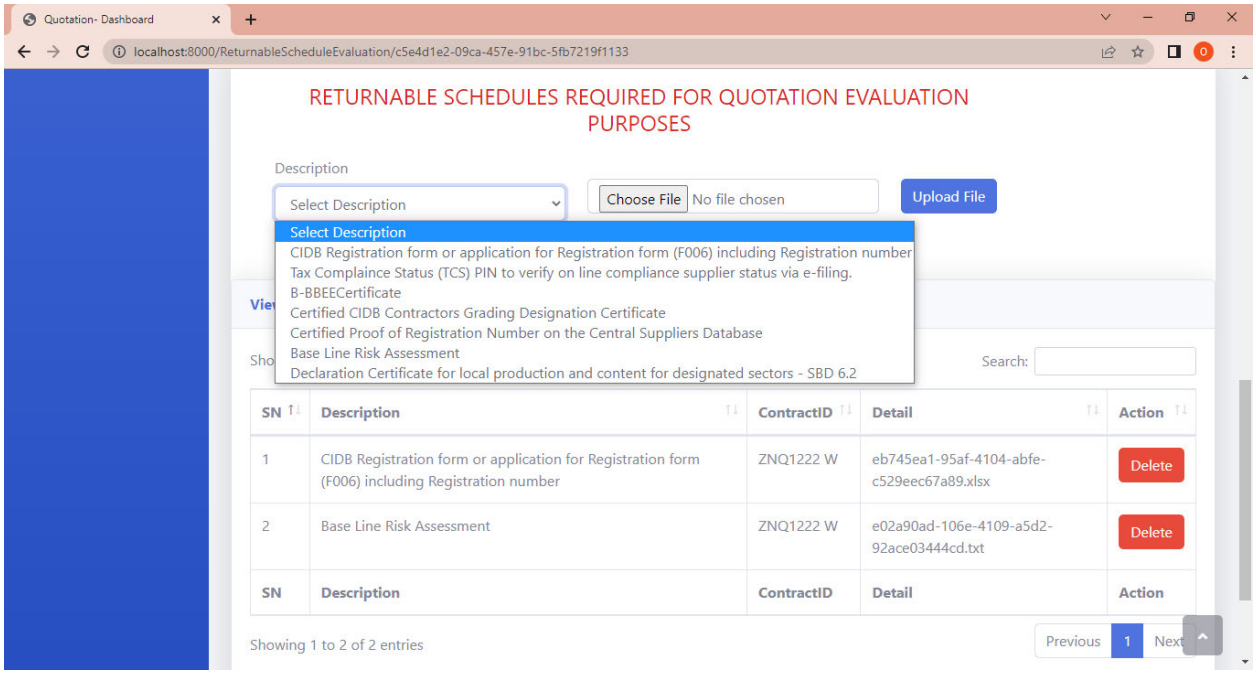
QUALITY CRITERIA: This page requests the bidder's quality criteria information. The bidder is expected to select a description and upload the appropriate file for the description selected in PDF format. Bidders/contractors can also delete any file wrong submitted.



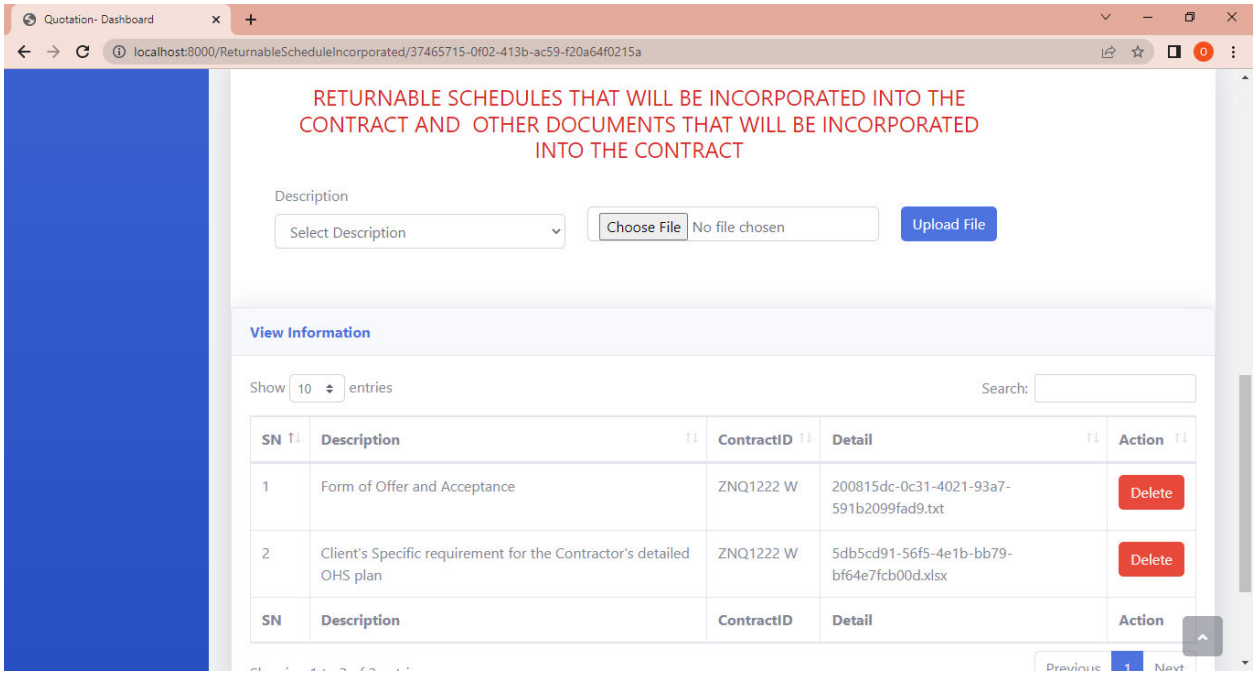
5.2.25. RETURNABLE SCHEDULE FOR EVALUATION



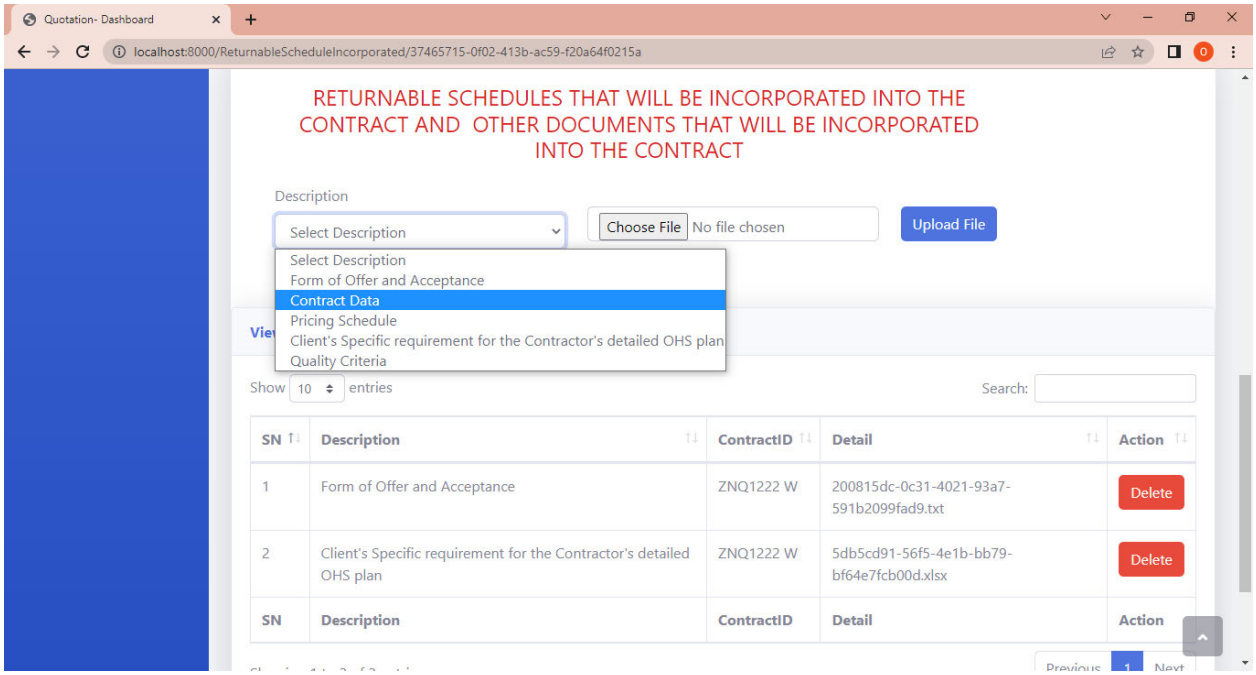
RETURNABLE SCHEDULES REQUIRED FOR QUOTATION EVALUATION PURPOSES: This page is for quality The bidder is expected to select a description and upload appropriate file for the description selected in PDF format. Bidders/contractors can also delete any file wrong submitted.

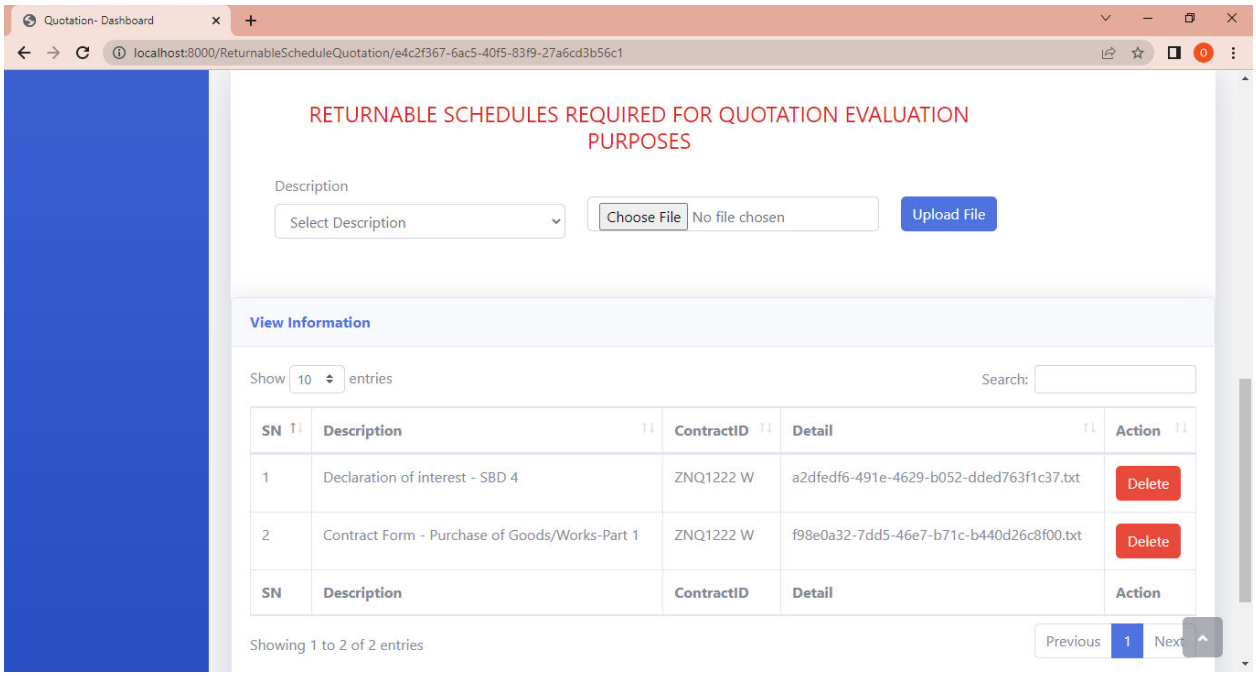


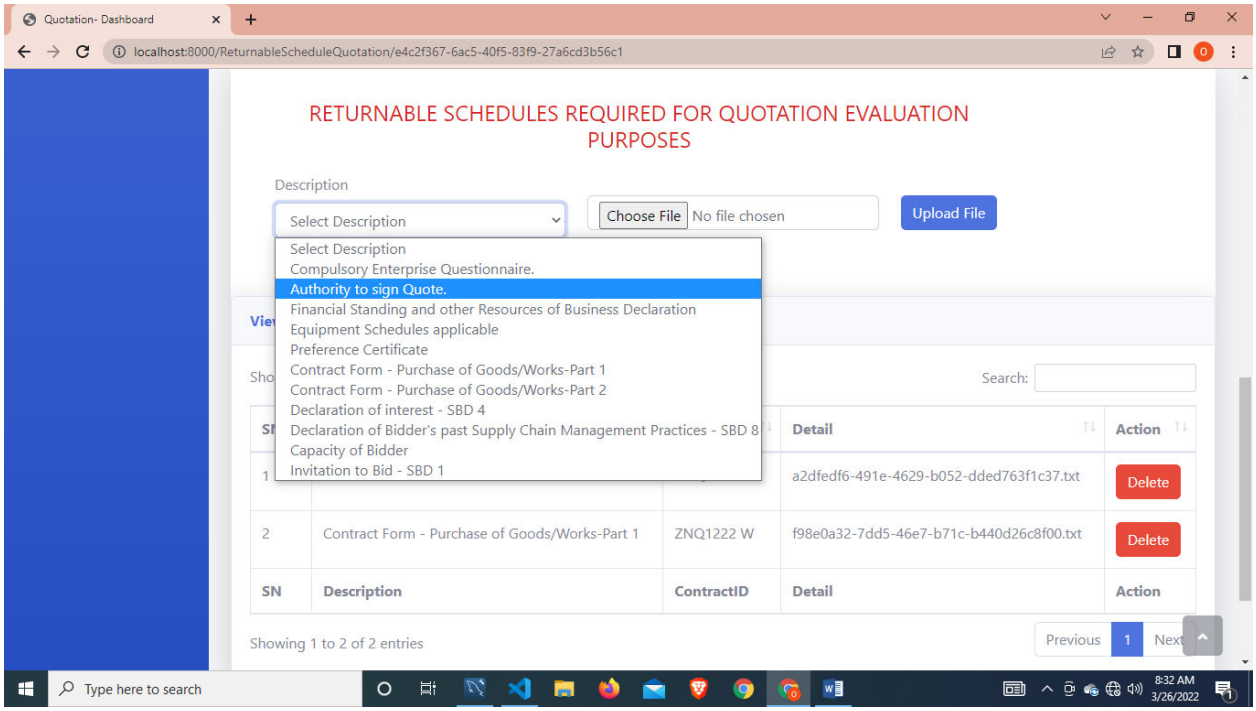
RETURNABLE SCHEDULES REQUIRED FOR QUOTATION EVALUATION PURPOSES: This page is for quality The bidder is expected to select a description and upload appropriate file for the description selected in PDF format. Bidders/contractors can also delete any file wrong submitted.



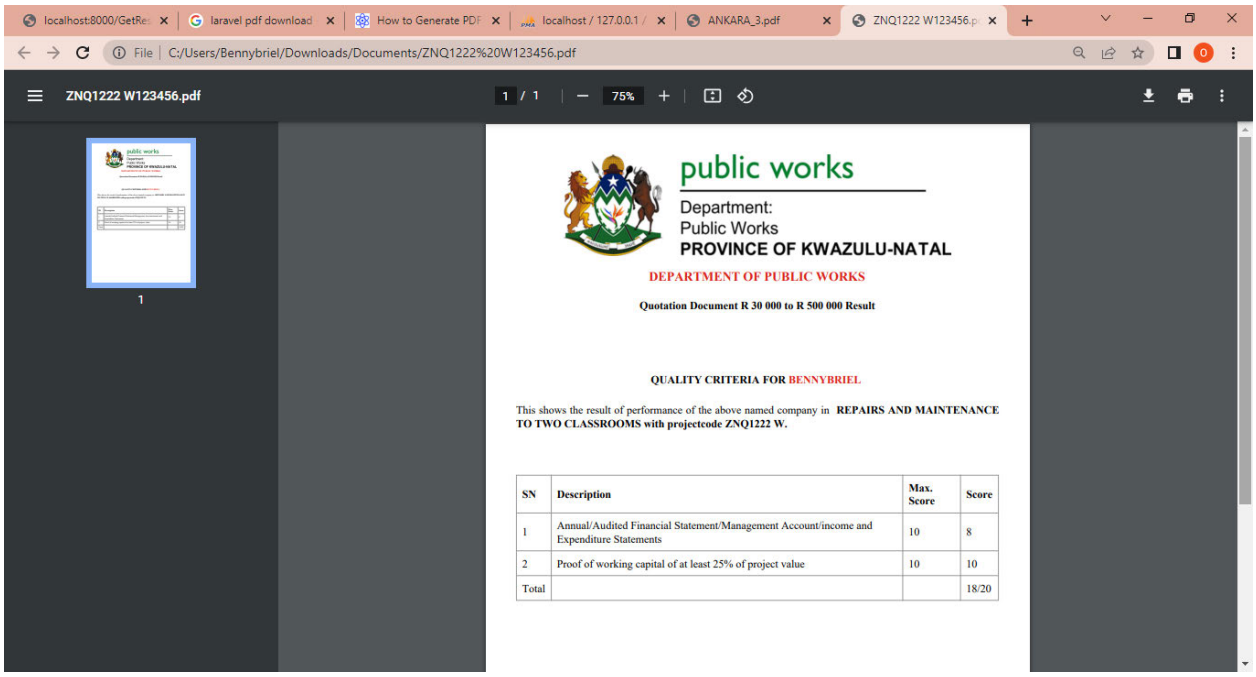
RETURNABLE SCHEDULES THAT WILL BE INCORPORATED INTO THE CONTRACT AND OTHER DOCUMENTS THAT WILL BE INCORPORATED INTO THE CONTRACT: This page is for quality. The bidder is expected to select a description and upload the appropriate file for the description selected in PDF format. Bidders/contractors can also delete any file wrong submitted.







5.2.21 THE RESULT PAGE



THIS IS THE PAGE FOR RESULTS: The results page presents the final tender results. The tender award with the entire scoring points is uploaded here.

The operations expressed in Illustrations 5.2 to 5.8 are the salient deliverables that this study has identified for the development of the automated tendering system at the KZN DPW. Validating the illustration presented in the automation of tendering will authenticate these reactions, and the mitigating actions proffered will drastically minimize or eliminate delays in project tendering.

5.3 Cost analysis of the automation tendering system.

Cost analysis for automation tendering system involves evaluating expenses related to automation, resources, human resources, and other tools, as well as evaluating the return on output generated by sequence of activities (Secoda 2024). Adopting automized tendering can significantly enhance your construction projects' cost-efficiency. This vital tool enables effective project control, helping to maximize productivity and profitability as such activity as paper printing is limited. Following are factors that contribute to cost effectiveness:

5.3.1. Initial implementation costs versus life span

Costs have been viewed as a key outcome in implementation of automation model, yet there is less contribution on how to measure costs as distinct from more traditional cost-effectiveness analyses (Gold, McDermott, Hoomans and Wagner 2022). While automation can lead to long-term cost savings, the initial investment required to implement automated systems can be significant. It involves expenses such as purchasing equipment, software, training employees, and restructuring processes. Due to these upfront costs, small businesses or industries with limited resources may find it challenging to adopt automation.

5.3.2. Reduction of workforce thereby reduction on salaries

Implementing automation to perform tasks and processes results in the potential loss of jobs for human beings. When KZN Department of public works start using machines and robots to enhance their productivity, the unemployment rate increase, particularly for low-skilled or repetitive roles. This can lead to economic and social challenges, including income inequality and unemployment rates.

5.3.3. Automation reduces corruption

Globally, the World Economic Forum has estimated that the cost of corruption is about R2.6 trillion a year. The impacts of corruption disproportionately affect the most vulnerable people in society. Widespread corruption deters investment, weakens economic growth and undermines the rule of law. Despite these unprecedented levels of power outages, the construction industry contributed 2.7% to South Africa's total GDP and the construction industry has been known as the face of corruption (Stephan 2022). The introduction of

automation tendering will curve the irregular expenditure in the construction industry (Stephan 2022). The automation an online platform for tendering, reduction of corruption practices, availability of electronic processes which limit the human involvement, the contribution of automation of operations in respective departments in reducing corruption and this leads to reduction of irregular expenditure and cost saving.

5.3.4. Improves Efficiency and Speed of Procurement Process

Automating the tendering process not only accelerates the workflow but also boosts overall efficiency, leading to direct cost savings (McKinsey, 2024). This allows procurement officials to save substantial time, which can be better utilized for other critical tasks. McKinsey (2024) reports that automation could reduce the number of hours worked in the South African tendering process by 30% by 2030.

5.3.5. Creates a centralised system therefore privacy enhanced

Traditional tendering methods often lead to redundant entries and potential fraud in contracts. However, automation can help minimize such risks by creating a centralized repository for all data and documents. This centralized system enables the tendering team to efficiently locate necessary documents, reducing the potential costs associated with misplaced information.

5.3.6. Reduce Manual Errors and the use of paper

Compared to traditional methods, automation eradicates paper-based documentation and reduces the likelihood of mistakes (Gu, Sabrina, Fan, & Sohail, 2023). Conventional approaches not only consume considerable time but also introduce risks of human error. Automating the tendering process and promoting a paperless environment are effective ways to cut down on errors and costs. It also facilitates the secure and easy storage of information and data (Gu et al., 2023).

5.3.7. Improved accuracy and quality

Automation can greatly enhance productivity by reducing the need for manual work and accelerating various processes. Automated systems are designed to execute tasks faster and more efficiently than humans (Austin, 2014). This can lead to increased output and shorter production cycles, which positively impact the overall costs of tendering (Austin, 2014).

5.3.8. Enhanced efficiency and cost savings

Automated systems are designed to carry out tasks with high accuracy and uniformity (Kalra, Chakraborty, Fine & Reicher, 2020). This leads to better precision and quality in output, effectively removing the costs associated with defects (Kalra et al., 2020). By eliminating

human errors and inconsistencies, automation can significantly boost customer satisfaction, ultimately leading to increased profitability.

5.3.9. Scalability and flexibility

Scalability in computing refers to the capacity to increase or decrease IT resources as needed to adapt in continuously change (Broadcom 2024). Broadcom (2024) further says scalability is one of the hallmarks of the computer and the primary driver of its exploding popularity with businesses. Automated systems can be readily scaled up or down to accommodate shifts in demand. Automation provides the agility to modify production rates and adapt efficiently to changes in the market.

5.3.10. Cost benefits and return on investment

Tendering has always been a vital if not always overtly recognized enterprise function, yet in the current urgent climate, an organization tendering teams may be finding themselves on the front line. One proven tool to help tendering team optimize their operations is an automated tendering model. Automating tendering lowers labor costs and drives operational efficiency, resulting in a generous return on investment (ROI). A 2018 analysis by The Hackett Group quantified the performance advantage automated tendering can deliver, including 21% lower manual costs and 29% fewer full-time equivalent staff than other organizations. Overall, these world-class tendering groups have a significantly higher ROI a 10.7 times payback on investment in tendering, compared to a 4.7 time for their peer-group companies. Tendering teams are achieving this level of ROI both by efficiently standardizing and automating routine tasks which lowers the costs of many activities, and by effectively boosting productivity levels allowing staff to focus on more strategic initiatives. Automating the tendering process, from creation through approvals and purchase order creation greatly reduces the manual touchpoints, speeding the cycle and fuelling efficiencies and cost savings.

It is estimated that using a tendering solution to automate requisitions can save 40 to 70% over the costs associated with a manual system.

5.4. Risk assessment for automation tendering system.

5.4.1 Technical challenges and limitations

The concept of cloud computing involves decoupling software from its underlying operating system and hardware, distinct from virtual computing (Aladin, Ahmed, Ali, Kadhum, Zolkipli & Alsariera 2017). Aladin et al. (2017) further explain that the software becomes independent of the hardware and operating system; if these components fail, the software automatically relocates to other resources. However, automation systems heavily rely on advanced

technology and intricate configurations. Issues like software malfunctions, hardware breakdowns, or cybersecurity threats can disrupt operations and cause downtime. Consequently, some tasks are difficult to automate due to their complexity or the necessity for human oversight.

5.4.2 Evolving Business Landscape

One of the primary causes of these risks is the challenge of integrating advanced technology with systems operated by humans (Gleematic 2023). As automation grows more sophisticated and is closely integrated with critical workflows, the likelihood of technical issues and failures increases, leading to operational disturbances and costly downtime (Gleematic 2023). Economic fluctuations and changes in the market environment can impact the ability of an automated tendering system to deliver, as people may resist adapting to these changes.

5.4.3 Technology and Innovation

The implementation and use of automation focus on ensuring high performance, security, and user satisfaction (Roger, Kahraman, Drews, Powell, Wang, Baxla & Sobalkar 2019). Additionally, there needs to be a dynamic balance between human input and automation to address emerging technological complexities and related human factors. Rapid advancements in technology can render procured goods or services obsolete, necessitating significant upgrades or replacements, often at extra costs (Roger 2019 et al.).

5.4.4 Reputation Risks

Reputational risk is a significant concern for a company’s financial sustainability in the long term (Jones 2020). With heightened scrutiny and ongoing regulatory demands, alongside stakeholder expectations and social media influence on perceptions of automation, there is a need to identify and mitigate reputational damage to achieve anticipated profitability (Jones 2020). Automation platforms allow for external oversight beyond a company’s control. Anticipating these risks enables a deeper evaluation of a company's goals and strategies. The organization's reputation can suffer if the automated tendering system fails to meet expectations (Jones 2020).

5.4.5 Regular software updates

A frequently overlooked but essential aspect of back-office security is the regular updating of software (Dunaj 2024). This ongoing maintenance is critical for safeguarding systems against new threats and vulnerabilities. Regular updates often provide access to new software features (Dunaj 2024). Each update of an automated solution typically includes fixes for security gaps identified since the previous version (Dunaj 2024).

5.4.6 Stolen information

Should the administrator or user forget to log out on the automated system and the gadget used land it wrong people the entire bidding information is at risk to be stolen (Amos 2023). And such simple mistake can result in unapproved access to confidential data compromising the personal and business information. Over depending on automation in cybersecurity can introduce various risks and challenges to institution (Amos 2023). This edify in addressing numbers of threats companies face regular, but a balanced approach is critical.

5.4.7 Unauthorized access

Unauthorized access in cybersecurity happens when an individual gains logical or physical login without permission to a network, system, application, data, or other resource (Pryimenko 2024). Pryimenko (2024) further mentions unauthorized access include bypassing security protocols or abusing susceptible in IT infrastructure to get access to systems that should be attainable only to permit users. This risk involves cyber attackers gaining entry to systems or data for which they lack proper authorization. The threat may come from an outside intruder or even an employee who surpasses their permitted access rights (Pryimenko 2024).

5.4.8 Insider threats

Security teams who hold low-code automation for insider threat use cases gain the scute and orderliness to mitigate insider risk holistically (Kennedy 2023). This means that addressing risks instituted by employees with uplifted access, spiteful insider threats, third-party risk and penumbra IT use. Kennedy (2023) states that internal threats arise from within the organization, posing a significant risk to business process automation. For instance, a disgruntled employee might misuse their access to critical data for personal gain or to harm the company.

5.4.9 Phishing attacks

Phishing involves designing website that duplicate an existing authentic business website to defraud users and obtain illegally their credentials and login information (Qabajeh, Thabtah & Chiclana 2018). These attacks deceive employees into disclosing sensitive details, such as login credentials, often through fraudulent emails or websites. A single click on a harmful link can jeopardize the entire back-office system (Qabajeh et al., 2018). The consequences of phishing can be severe, as affected legitimate users face identity theft and data breaches, eroding trust in automated tendering processes (Qabajeh et al., 2018). Phishing generally occurs through emails that appear to come from reputable sources, prompting users to update their login information by clicking a link within the email (Qabajeh et al., 2018).

5.4.10 Safety level

Automation can be particularly advantageous in hazardous work settings. By substituting humans with automated systems in roles that present risks to human safety, automation can significantly reduce the likelihood of accidents, injuries, and workplace dangers. Proper safety in automated systems should ensure that the possible risk for injuries is at zero for employees (Sanders 2024).

5.5 Mitigation of automation risk

A mitigation plan in the context of automation refers to the process of identifying and implementing measures to reduce the impact of risks on a company's significant information and operations. It includes creating backup systems, storing important data off-site and reduce, avoid, or transfer risks. Following the are risk mitigation strategies:

5.5.1. Adhere to Security Guidelines

- Tailor departmental policies to incorporate specific security measures and anti-virus protocols, especially for users classified as high-risk.
- Establish a reporting system for security incidents.
- Develop secure operating procedures.
- Acknowledge and involve employees in security practices.
- Safeguard overall productivity.
- Create and enforce robust password management policies.
- Share potential threats, signs of breaches, and best practices within the organization.
- Put in place a reliable backup strategy.
- Ensure privacy-conscious methods for sharing and processing data.
- Apply a Standardized Solution where multiple sets of instructions are prepared by experts and reused effectively.

5.5.2. Enforce Access Control

- Deploy web monitoring mechanisms.
- Implement multifactor authentication for administrative tasks, such as Microsoft Multi-Factor Authentication.
- Utilize DMARC (Domain-based Message Authentication, Reporting, and Conformance) for email verification.
- Incorporate secure login procedures.

5.5.3. Strengthen Endpoint Security

- Create a sophisticated network-based threat detection framework.
- Regularly update computer systems and software.
- Utilize firewalls, current antivirus solutions, email filtering tools, and browser security add-ons.
- Implement host-based intrusion detection systems (HIDS).
- Adhere to the security instructions provided by software and hardware vendors.

5.6. VALIDATION OF THE MODEL

A survey was carried out among experts engaged in tendering within the KZN Department of Public Works to assess the proposed automated tendering system (Illustration 5.2–5.8). Fourteen professionals, including architects, quantity surveyors, builders, and officials from the KZN DPW, participated in the survey using a validation questionnaire. The analysis of the data involved calculating the mean score, percentage frequency, and performing a test of means difference. The mean score range used for interpreting the data was based on the results from the first phase of the questionnaire analysis.

5.6.1 Section 1 – Biographical Data

This section enables the stratification of data according to various demographic variables, such as age, gender, educational background, and professional experience. Such stratification is instrumental in ensuring that the interpretation of the subsequent sections is nuanced and considers demographic influences on the responses. It is the intent of this introductory section to set the stage for a comprehensive analysis, establishing a contextual framework for the insights derived from the more thematic aspects of the questionnaire.

Table 5.6.2: District of Employment

	Frequency	Percent
Ethekwini	2	20%
Ugu	1	10%
Harry Gwala	1	10%
Umgungundlovu	3	30%
Contractor	2	20%
Professionals	1	10%
Total	10	100.0

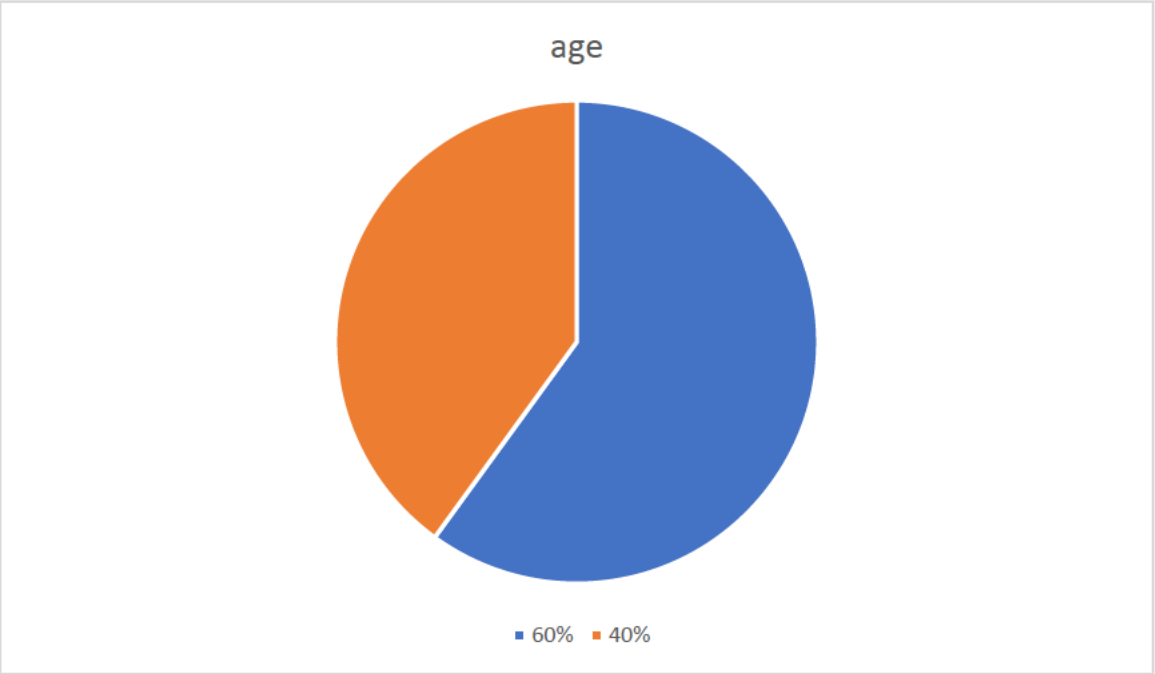
The regional breakdown of respondents is as follows: Umgungundlovu had the highest participation at 30% indicating a strong engagement from this area in the automated tendering process. Other region such as Ethekwini is rated at 20% and with contractors rated 20%, also showed notable representation of other professionals at 10%. The data suggests significant regional disparities in participation rates, which is statistically supported by a goodness of fit test result of $p < 0.001$. This finding highlights the geographical diversity of the sample and may reflect the varying levels of construction activity or interest in tender processes across the regions.

Table 5.6.3: Gender

	Frequency	Percent
Female	3	30
Male	7	70
Total	10	100.0

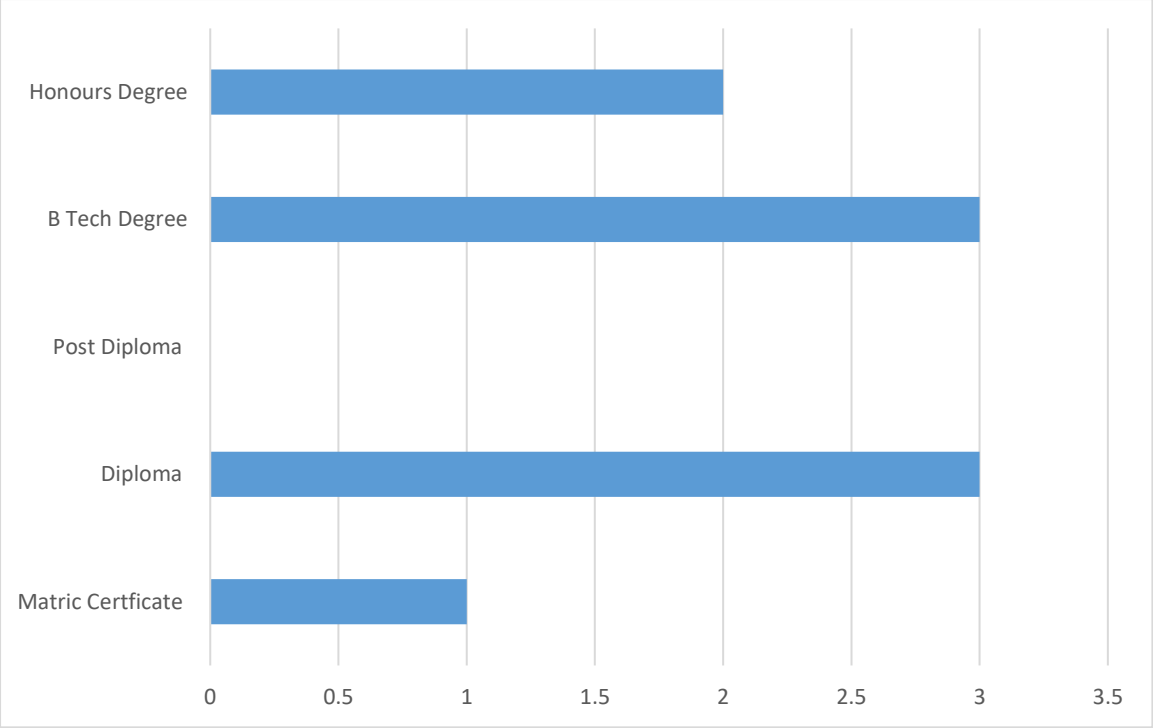
Gender distribution is skewed towards male respondents, who make up 70% of the sample, compared to 30% female respondents, a disparity that is statistically significant ($p = 0.008$), reflecting the gender dynamics within the construction industry.

5.6.3 Age Distribution



The age distribution among respondents reveals a concentration in the 31-40 age range, each accounting for 60% of the participants. Those aged 41-50 constitute 40%. This suggests a workforce with a significant proportion in the mid-career stage, which may correlate with a higher level of experience in the industry ($p < 0.001$).

5.6.4 Highest Formal Qualification



The educational qualifications of the respondents showcase a diverse array of academic achievements. The majority hold either a Diploma or a Technical degree, each accounting for 30% of the participants. This is equal to those with bachelor's degrees at 30% and follows by Honours degrees at 20%. Postgraduate Diplomas, are less common, indicating a workforce with a strong foundation of tertiary education, yet there is 10% with matric certificate. This diversity in educational backgrounds reflects a range of expertise within the construction tendering sector ($p < 0.001$).

Table 5.6.5: Summary of factor analysis conducted for category analysis.

KMO and Bartlett's Test

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	
Extent of your understanding of the evaluation of funct	0,981	-0,072	-0,001	0,049	S13
Viewing data of bidder's information	0,981	-0,072	-0,001	0,049	S9
Extent of your understanding of the operating returnab	0,981	-0,072	-0,001	0,049	S10
Understanding of capturing contractors bank informati	0,981	-0,072	-0,001	0,049	S19
Extent of your understanding of updating of the record	0,744	-0,177	-0,209	-0,495	S6
Operating of contract set up page	0,744	-0,177	-0,209	-0,495	S8
Extent of your understanding of deleting of records	-0,084	0,987	0,009	0,044	S7
Updating record after checking quality	-0,084	0,987	0,009	0,044	S12
Understanding of capture process of principal agent inf	-0,084	0,987	0,009	0,044	S20
Understanding of contract creation process	-0,222	0,470	0,455	0,051	S18
Understanding of dashboard to add contract stage	-0,119	0,366	0,890	-0,124	S4
Extent of your understanding of bid information upload	-0,135	-0,141	0,821	-0,026	S5
Extent of your Understanding of the quality criteria pag	0,518	-0,355	-0,112	0,651	S11
Understanding of the login page	-0,137	0,360	-0,371	0,638	S1
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normaliz					
a. Rotation converged in 5 iterations.					

KMO Bartlett and Sphericity values could not be generated (in all sections) due to:

Insufficient Sample Size: A small sample size relative to the number of items can lead to instability in the correlation matrix. Factor analysis typically requires a larger sample size to produce stable and reliable results.

Data Issues: Missing data, outliers, or errors in data entry can affect the correlation matrix, making it non-positive definite. Ensuring clean and complete data is crucial.

Low Variability: If some variables have low variability (i.e., most responses are similar), it can cause problems in the correlation matrix. This is common in pilot studies where the sample may not be diverse enough.

4.6.7 Theme: User Understanding and Proficiency in System Operations

Component 1: Understanding of Functional Processes

- S13: Extent of your understanding of the evaluation of functionality
- S9: Viewing data of bidder's information
- S10: Extent of your understanding of the operating returnable schedule page
- S19: Understanding of capturing contractors bank information
- S6: Extent of your understanding of updating of the record page
- S8: Operating of contract set up page

Component 2: Coordination and Quality Control

- S7: Extent of your understanding of deleting of records
- S12: Updating record after checking quality
- S20: Understanding of capture process of principal agent information
- S18: Understanding of contract creation process

Component 3: Dashboard and Information Management

- S4: Understanding of dashboard to add contract stage
- S5: Extent of your understanding of bid information upload page

Component 4: Quality Criteria and Initial Access

- S11: Extent of your Understanding of the quality criteria page
- S1: Understanding of the login page

Component Matrix[a]			
	Component		
	1		
Accurate coordination of the dashboard	0,780		S2
Accurate coordinating of the dashboard to add informa	0,780		S3
Extraction Method: Principal Component Analysis.			
a. 1 components extracted.			

Theme: Dashboard Coordination Accuracy

The component matrix indicates that both items, "Accurate coordination of the dashboard" and "Accurate coordinating of the dashboard to add information," have strong loadings (0.780) on a single component extracted through Principal Component Analysis (PCA), as per the identified theme.

Rotated Component Matrix[a]					
	Component				
	1	2			
Viewing bid results page	0,946	0,155		S16	
Accessing and viewing of project information after eval	0,872	-0,182		S15	
Accessing documents required for evaluation	0,155	0,946		S14	
Accessing and viewing award list page	-0,182	0,872		S17	
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					
a. Rotation converged in 3 iterations.					

Theme: Evaluation and Post-Evaluation Information Management

1. **Component 1: Viewing Results and Information Post-Evaluation**
    1. Viewing bid results page (0.946)

2. Accessing and viewing of project information after evaluation (0.872)

2. **Component 2: Accessing Documents and Awards**
    1. Accessing documents required for evaluation (0.946)
    2. Accessing and viewing award list page (0.872)

Table 5.6.6: Further analysis on the automation app usage

Factor	**Participant response**
Understanding the login page	Very easy to understand
Accurate coordination of the dashboard	Very easy to coordinate
Accurate coordination of the dashboard to add information	Easy to coordinate
Understanding the dashboard to add the contract stage	Very easy to understand
Extent of your understanding of the bid information upload page	Very easy to understand
Extent of your understanding of updating the record page	Very easy to update
Extent of your understanding of the deletion of records	Very easy to delete records
Operating the contract set up page	Very easy to operate
Viewing bidder's information data	Easy to view bidder's information
The extent of your understanding of the operating returnable schedule page	Easy to understand
Updating records after checking quality The extent of your understanding of the evaluation of functionality	Very easy to update Very easy to understand
Accessing documents required for evaluation	Very easy to access
Accessing and viewing of project information after evaluation	Easy to access
Viewing bid results page	Very easy to view
Accessing and viewing award list page	Easy to access and view
Understanding of contract creation process	Very easy to understand
Understanding of capturing contractors bank information	Very easy to capture
Understanding of capture process of principal agent information	Very easy to capture

Table 5.6.6 presents the respondents' understanding on the usage of the developed automated tendering model. The respondents understanding on login page was very easy to understand. This indicate that the model is very easily to be understood by administrator and bidders. Respondents also indicates that on the accurate coordination of the dashboard, it is very easy to coordinate dashboard. Majority of respondents easily coordinate the add information page on the dashboard. However, the there is also an easily understanding on the operation of the returning documents. This indicates a strong belief that automation can significantly increase the efficiency tendering at KZN DPW.

Table 5.6.7: Summary of cost analysis

Rotated Component Matrix				
	Component			
	1			
Enhanced efficiency and cost savings	0,982			S28
Reduce Manual Errors and the use of paper	0,973			S26
Automation reduce corruption	0,881			S23
Improves Efficiency and Speed of Procurement Process	0,512			S24
Creates a Centralized System	0,158			S25
Job displacement and unemployment	0,142			S22
Improved accuracy and quality	0,128			S27
Initial implementation costs	0,114			S21
Scalability and flexibility	0,111			S29

Theme: Evaluation and Post-Evaluation Information Management

1.**Component 1: Cost analysis**

S28. Enhanced efficiency and cost saving (0.982)

S26. Reduce manual errors and the use of paper (0.973)

S23. Automation reduced corruption (0.881)

Theme: enhanced efficiency and cost saving

The component matrix indicates that both items, "enhanced efficiency and cost saving" and "Reduce manual errors and the use of paper" have strong loadings (0.982 and 0.973) on a single component extracted through Principal Component Analysis (PCA), as per the identified theme.

Table 5.6.8: Further cost analysis in form of a table

Understanding of cost analysis	Easy to understand
Understanding of risk analysis	Easy to understand
Initial implementation costs	Strongly agree
Job displacement and unemployment	Agree
Automation reduce corruption	Strongly agree
Improves Efficiency and Speed of Procurement Process	Strongly agree
Creates a Centralized System	Agree
Reduce Manual Errors and the use of paper	Strongly agree
Improved accuracy and quality	Agree
Enhanced efficiency and cost savings	Agree
Scalability and flexibility	Agree

Table 5.6.8 presents the respondents' understanding on the cost analysis of automated tendering model. The respondents agree that automated tendering will have an impact on job displacement and unemployment. As the automated model will reduce corruption, respondents strongly agree that project cost will reduce. 100 % of respondent have strongly agree that automated tendering system will improve efficiency and speed of procurement process. Respondents agree that the model will improve accuracy and quality. Cost saving also will be enhanced by the automated model as respondents agree.

Table 5.6.9: Summary of Risk analysis

Rotated Component Matrix				
	Component			
	1			
Technical challenges and limitations	0,952			S30
Regular software updates	0,933			S34
Reputation Risks	0,912			S33
Technology and Innovation	0,623			S32
Changing business environment	0,412			S31
Stolen information	0,225			S35
Unauthorized access	0,129			S36
Insider threats	0,127			S37
Phishing attacks	0,115			S38
Increased safety	0,111			S39

Theme: Evaluation and Post-Evaluation Information Management

1.**Component 1: Risk Analysis**

S30.Technical challenges and limitation (0.952)

S34. Regular software updates (0.933)

S33. Reputation Risk (0.912)

Theme: enhanced efficiency and cost saving

The component matrix indicates that both items, "Technical challenges and limitation" and "Regular software updates" have strong loadings (0.952 and 0.933) on a single component extracted through Principal Component Analysis (PCA), as per the identified theme.

Table 5.6.10: Further risk analysis in a form of a table

Technical challenges and limitations	Major
Changing business environment	Major
Technology and Innovation	Major
Reputation Risks	Major
Regular software updates	Major
Stolen information	Minor
Unauthorized access	Major
Insider threats	Minor
Phishing attacks	Minor
Safety Level	Agree

Table 5.6.10 presents the respondents' understanding on the risk analysis of automated tendering model. The respondents agree that automated tendering will have major technical challenges and limitations, and this means that the risk is too high. Respondents also believe that the automated tendering model will have a major impact in changing business environment. 98% of respondents believes that automated model will require major software updates as it the system will be used regularly. Respondents also believe that they will be minor information stealing as the system have minor phishing attacks.

Table 5.6.11: Evaluation of model comparing to manual

Factor	**Automated system**	**Manual system**
Corruption & unethical practices	Eliminate corruption	Common occurrence
Political constrains	No physical interaction	Corruption
Inefficiency and delay's Response	Time consumption	Time delays
Need for automation	Mitigation of challenges	Human involvement

Table 5.6.11 presents evaluation on comparison of automated tendering model and manual system. Elimination of corruption by automated tendering system while corruption and unethical practices are common occurrence on manual tendering system. The will be limited political constraints on automated tendering system as there will be limited human interaction and manual tendering have 100% physical interaction which leads to corruption. The automated system consume time delays while manual system is full of delays.

5.7 SUMMARY AND CONCLUSION OF THE CHAPTER

The chapter presents the automated tendering process for the KZN Department of Public Works. The system starts with having to login and check the quotation and on the side of the department, the administrator loads the quotation. The process begins by logging in to access and review the quotation, while the department administrator uploads the quotation. The bidder fills out the project information as per the folders on the dashboard and uploads all the returnable to the system. On the other hand, the administrator monitors and downloads the documents as a created contract file for each contract.

On the closing date, the system automatically closes itself, and the user can no longer upload documents. Only the administrator can access the system, populate the list of submitted bidders and upload the list to the submitted bidder folder on the dashboard for transparency purposes. This caters for a tender opening, as it is a requirement of the manual tendering processes.

After all contract quotations are received and the tender closes, the evaluation process commences. The bid evaluation committee is required as the presented system is still at an early stage and requires oversight by human resources. The evaluation committee can access the system and conduct digital assessments without the need for in-person in the boardroom. Using the automated system means that all six factors discussed in Chapter 2 will be mitigated and effective tendering will be achieved.

The administrator creates the project folder on the system, uploads all project **tender planning** information onto the system, and the user or bidder fills out the tender on the system. The professional's **competency** is assessed, and the automated system takes over manually. Human involvement is limited, and automation eliminates paperwork mistakes. To increase the **effectiveness** of tender processes, automation eliminates delays, maximizes the quality of work, and minimizes the cost of tendering.

Automating tender processes eliminate the element of corruption in the system by minimizing direct interaction between clients and contractors, thus reducing the opportunity. The politicians' involvement is limited as most of the processes are automated, thereby reducing human intervention that can serve political interests.

In conclusion, this research is a feasibility study, and it proves that it is necessary for the KZN Department of Public Works to be automated. Automated tendering processes have numerous benefits. Since this is a feasibility research study, the automated tendering system being introduced is not yet fully automated. The automated system has been tested and found to be suitable for mitigating most of the challenges in the tendering processes of KZN DoPW. As the system continues to evolve, its ultimate objective is to eliminate all human involvement, becoming capable of independently evaluating and awarding project tenders.

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter discusses deductions and commendation arising from the inspection of the pertinent collected works as well as the discoveries derived from the data analysis. The literature study advocated for the automation of the tendering system at the KZN DPW, citing a range of manual system issues, including those caused by poor tender planning, incompetence of the professional team, the ineffectiveness of tender processes, corruption and political constraints, unethical practices, as well as the potential benefits of an automated solution. The literature study investigated the necessity of developing an automated tendering system at the KZN DPW. An empirical study was conducted to test the cogency of the hypothesis. One set of questionnaires, an interview question and a historical data question were arranged for officials, contractors, and consultants of the KZN DPW. The results were organized based on the data gathered.

Chapter 3 detailed the research's methodology, identified the pilot interview respondents and highlighted the valuable input gained from them. The procedures involved in compiling the questionnaire are also discussed. The outcomes of the survey are presented in Chapters 4 and 5, with input from the public works' officials, contractors and consultants of KZN. The empirical investigation revealed the need for the KZN DPW to develop an automated tender system. Issues such as poor tender planning, the competency of the professionals, the effectiveness of the tender system, corruption and political constraints, unethical conduct and the benefits of the automation will be mitigated by the introduction automated tendering.

6.2 CONCLUSIONS

In Chapter 4, the factors explored by their average mean scores on tendering at the KZN Department of Public Works were ranked. The leading factors are political constraints and unethical practices, with corruption constraints trailing closely behind. The effectiveness of the tender processes followed. Based on the factor analysis conducted in the preceding chapters, it was determined that every aspect considered within each category satisfactorily delineates the subproblems. This was evidenced by the significant loadings attained for each category of sub-problems, which were greater than 0.50 in all cases.

Each category was reviewed, and the factors that impact each management issue were identified.

i. Based on the research findings, the subsequent conclusions with regards to "political constraints" were drawn.

- Political conflict of interest was rated the most under political constraints and unethical practices. The study shows that political conflicts of interest often exert influence on tender processes.
- Corruption practices lead to the appointment of a non-capacitated contractor, which affects the delivery. Automated tendering mitigates corruption practices as it limits physical contact among humans.

In summary, the use of an automated system is essential to prevent disruptions to tendering processes.

ii. Based on the outcomes of the research, the succeeding conclusion regarding "corruption constraints against effective tendering" was drawn.

- Under this category, the leading factor is pre-bid meetings. These meetings are meant to brief bidders with the technicalities and functionality of the tender; however, they develop relationships between bidders and consultants and department officials, and such relationships lead to corruption practices.

In summary, it can be concluded that an automated tender system can mitigate direct physical contact between the parties, which leads to the appointment of the preferred bidder.

iii. From the research findings, the ensuing conclusions in relation to "effectiveness of tendering processes" were drawn.

- Respondents ranked time as the leading factor impacting the effectiveness of tender processes. Long manual tendering processes often lead to time delays during tendering processes, and while delays occur in tender awards, issues such as corruption can creep into the tendering process itself. Automated tendering system can minimize the time taken to get to tender award. An automated tendering system can reduce the duration required to receive a tender award.

- Cost was another highly rated factor in terms of "the effectiveness of tender processes". This makes the manual tendering system more expensive due to the extensive travel, the printing of hard copies, and the necessity of physical meetings.

In summary, it can be concluded that an automated tender system is a necessity in the KZN Department of Public Works.

iv. Based on the research findings, the following conclusions with regards to "poor tender planning" were drawn:

- In this category, the leading factor is the nature of the tender, which can create lots of re-work after the planning and tendering stages.
- This is closely followed by the type of tender that can affect tender planning. Normally, the KZN Department of Public Works uses an open tender system, which requires more planning.

In summary, it can be established that an automated tender system can improve tender planning in the KZN Department of Public Works.

v. From the findings of the research, the ensuing conclusion in relation to the "competency of professionals" involved in tendering was drawn.

- Information sharing was rated highly among the factors that affect the competency of professionals involved in tendering.
- Respondents also rated ineffective communication as one of the factors that impact the competency of the professionals involved in tendering. The lack of communication among the tendering team can cause serious problems for the tender.

In summary, it can be inferred that most professionals lack communication, which leads to the incompetence of other professionals involved in tendering.

vi. Based on the findings of the research, the subsequent conclusions on the benefits of an automated tender system were drawn.

- The highest-ranked factor was the reduction of corruption, which relates to an automated tender system that mitigates corruption in tenders.
- Respondents also rated reduced paper usage as one of the benefits of automated tendering. The automated tendering process leaves fewer paper trails.

In summary, it can be concluded that an automated tendering system is a necessity in the KZN Department of Public Works.

6.3 RECOMMENDATIONS

According to research findings, the KZN Department of Public Works must consider adopting an automated tendering system to improve the current tendering processes.

Under political conflict of interest, the responsibility of the project planner and project manager is to monitor the automated system. Close management by the supervisors and the evaluation committee is necessary to prevent any misunderstandings within the system.

It is recommended that the KZN Department of Public Works consider upgrading the manual use of tendering system to an automated system to remain current as the world transitions to digital systems.

The findings of the study reveal a remarkable need for corruption constraints against ineffective tendering. The automated tendering process limits corruption as the system is responsible for keeping records and processing the tendering automatically. Corruption hazards are addressed within the automated tendering process.

The effectiveness of tendering processes also impacts the necessity of an automated tendering system in the KZN Department of Public Works; this can lead to major improvements in tendering and tendering effectiveness.

It is recommended that the KZN DPW consider the adoption of an automated tendering system so that the tendering processes can be more effective. Administrators need to ensure thoroughness to prevent any mismanagement of the automated system. All costs occurring during tendering will be limited as the automated tendering system reduces the use and cost of paper and travel expenses.

Following the findings regarding the competency of professionals involved in tendering, the automated tendering system will assist the professionals in maintaining their performance in managing tenders. The introduction of an automated tender system reduces the responsibilities of professionals involved in tendering as it takes over some of the human resource tasks.

It is recommended that automated tender processes be adopted by the KZN DPW to improve tender planning. The automated tender process will automatically keep all planning records, which will improve tendering processes.

The findings under the benefits of automated tendering reveal that since the study is a feasibility study, it is therefore not yet understood, as some respondents were unsure in their scorings. However, the research shows that the introduction of automated tendering can mitigate corruption, reduce the use of paper, enhance competitiveness by providing transparency and reduce the cost of tendering.

It is therefore recommended that the KZN Department of Public Works consider the adoption of automated tendering processes.

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