JCBM

ISSN 2521-0165

Volume 7, Number 1, June 2024

JOURNAL OF CONSTRUCTION BUSINESS & MANAGEMENT

http://journals.uct.ac.za/index.php/jcbm/index

JCBM

Table of Contents
Volume 7, Number 1, June 2024

ABOUT JCBM

The **Journal of Construction Business and Management (JCBM)** is an open access journal published bi-annually by the University of Cape Town Libraries, South Africa. The Journal is hosted by the Construction Business and Management Research Group of the University of Cape Town. The journal aims to explore the experience of construction industry stakeholders and trends in the global system. It aims to publish peer reviewed and highly quality papers emanating from original theoretical based research, rigorous review of literature, conceptual papers and development of theories, case studies and practical notes. The journal also welcomes papers with diverse methodological research approaches including qualitative, quantitative, and mixed methods. Contributions are expected from academia, public administrators, professionals in the public sector and private practice (such as contracting organizations and consulting firms) and other related bodies and institutions (such as financial, legal and NGOs).

The scope of **Journal of Construction Business and Management (JCBM)** covers but is not limited to construction management and project delivery, strategic management, decision making, skills development, organizational practices and procedures in construction business. The specific areas in construction management, sustainability in construction and project delivery include project planning/feasibility studies, procurement, resource management, international construction, ethical issues, industrial relations, legislative requirements and regulations, construction education, information and communication technologies, housing policies, and urban design and development. Strategic management in construction covers risk management, quality management, resilience and disaster management, cultural and societal management, project life cycle management, and knowledge creation and management. Among issues in construction organizational practices and procedures covered are business development strategies, human resources and career development, continuous professional development, leadership systems, marketing strategies, gender issues and corporate social responsibility.

Journal of Construction Business and Management (JCBM) is a peer reviewed journal. All research articles in this journal undergo rigorous peer review, based on initial editor and anonymised refereeing by at least two anonymous referees.

Journal of Construction Business and Management (JCBM) Partners:

University of Cape Town

Obafemi Awolowo University

The UCT Library takes no responsibility for the content published within journals that are hosted on OpenUCT: open journals and does not accept any liability arising out of the use of or the inability to use the information contained herein. The library, on behalf of itself and the University, assumes no responsibility, and shall not be liable for any breaches of agreement with other publishes/hosts.

Editorial Reviewer Panel

Dr. Emmanuel Itodo Daniel
University of Wolverhampton
United Kingdom

Dr Sandeep Shrivastava
Malaviya National Institute of Technology
India

Dr. Olalekan Oshodi
City University of Hong Kong, Hong Kong

Professor Erastus Mwanaumo
University of Zambia, Zambia

Professor Innocent Musonda
University of Johannesburg, South Africa

Professor Adekunle Adeleke
Universiti Utara, Malaysia

Professor Ifunanya Nwokoro
University of Lagos, Nigeria

Dr Elyas Jazayeri
University of Kentucky, United States

Professor Evelyn Teo Ai Lin
National University of Singapore
Singapore

Dr. Oluwaseun Dosumu
University of Lagos, Nigeria

Professor John Oko Ameh
University of Lagos, Nigeria

Professor Tabarak Ballal
University of Reading, United Kingdom

Dr Akeem Bolaji Wahab
Obafemi Awolowo University, Nigeria

Professor Ayodeji Aiyetan
Durban University of Technology
South Africa

Professor Clinton Aigbavboa
University of Johannesburg, South Africa

Dr Grace Kehinde Ojo
Obafemi Awolowo University, Nigeria

Dr Joel Ochieng' Wao
Tuskegee University, United States

Professor Justus Agumba
University of Johannesburg, South Africa

Professor Omokolade Akinsomi
University of Witwatersrand, South Africa

Professor Luqman Oyewobi
Federal University of Technology Minna
Nigeria

Professor Manya Mooya
University of Cape Town, South Africa

Dr Oluwayomi Babatunde
University of Witwatersrand, South Africa

Professor Richard Jimoh
Federal University of Technology Minna
Nigeria

Professor Tunde Timothy Oladokun
Obafemi Awolowo University, Nigeria

University of Cape Town
Journal of Construction Business and Management
http://journals.uct.ac.za/index.php/jcbm

Unveiling Construction Excellence: Strategies, Challenges and Innovations

Editorial June 2024

Abimbola Windapo
University of Cape Town
https://orcid.org/0000-0002-3162-6546

Nnedinma Umeokafor
University of Greenwich, London, United Kingdom
https://orcid.org/0000-0002-4010-5806

Introduction

The construction industry, as a cornerstone of economic development, plays a pivotal role in shaping infrastructure and enhancing the quality of life globally. This thirteenth issue of the Journal of Construction Business and Management presents a collection of research articles by twelve authors from South Africa, Tanzania, the United Kingdom and Zambia. The articles examine the intricacies of procurement strategies, quality management, project management tools, corruption and innovative construction methods. These articles collectively highlight the pathway towards achieving excellence in the construction industry of developing countries, addressing both persistent challenges and emergent solutions.

Discussion of the papers

In the dynamic interplay of construction practices, quality management and strategic procurement are key determinants of successful project outcomes. Bweupe and Mwiya (2024) explores the critical aspect of quality management in Zambia's ready-mix concrete (RMC) industry. Their research highlights the need for stringent quality control measures and adherence to guidelines to ensure the integrity and durability of concrete structures. The authors identify deficiencies in batching, mixing practices, and the limited adoption of modern weighing systems as areas needing improvement. Their recommendation include establishing an industry association, enhancing standardized practices and introducing third-party quality audits. This study highlights the significance of consistent quality management practices in mitigating potential structural risks and enhancing construction outcomes.

The second paper by Tembo, Kahanji and Mwanaumo (2024) present an insightful examination of procurement strategies for managing construction tender prices in the context of Zambia's World Bank-funded Improved Rural Connectivity Projects (IRCP). The study identifies factors such as cash flow assurance, guaranteed payments and comprehensive design completeness as key to a successful procurement strategy. The authors advocate for enhanced procurement planning, preferential procurement for local contractors and the establishment of differential procurement laws. These strategies aim to optimize tender price management, ensuring value for money and the successful completion of public infrastructure projects.

Sospeter, Chang'ah and Rwelamila (2024) – the third paper investigates the factors influencing the choice of project management tools and techniques (CPMTT) in Tanzanian public infrastructure projects. Using a mixed-method approach, their study reveals that project managers often prioritize easily accessible tools over those that align with organizational objectives and resource commitments. The study identifies four key factors influencing CPMTT selection: organizational support, ease of access and usefulness, project objectives and the project environment. The findings suggest that tailored training and better alignment of tools with project phases can significantly improve project delivery outcomes.

Addressing the cankerworm of corruption is essential for fostering a fair and competitive construction environment that supports sustainable economic development. The fourth paper by Soni and Smallwood (2024) examines the pervasive issue of corruption within the South African construction industry. Through interviews with construction industry professionals, the study highlights how corruption undermines economic growth, project performance and the equitable distribution of resources. The authors emphasize the need for transparency, the protection of whistle-blowers and the implementation of robust anti-corruption measures.

Lastly, Oyebode and Daniel (2024) examine the potential of the Dry Construction Method (DCM) to bridge Nigeria's significant housing deficit. Their research indicates that DCM, despite its higher initial costs, offers substantial benefits in terms of speed and affordability. The study highlights the importance of government support, local production of materials and adequate training of artisans to facilitate the adoption of DCM in housing delivery. The paper demonstrates that DCM is a viable solution to Nigeria's housing challenges with a potential to contribute to the overall sustainability of the construction sector.

Conclusion

This issue of the Journal of Construction Business and Management provides a comprehensive exploration of the challenges and innovations in the construction industry. From quality management in ready-mix concrete production to the strategic procurement of public infrastructure projects, and from understanding the impact of project management tools to addressing systemic corruption and exploring innovative construction methods, these articles offer insights into the challenges and practical solutions. The depth and breadth of the topics covered reflect the complexity of the construction industry and the concerted efforts required to navigate its challenges.

We extend our gratitude to the authors for their invaluable contributions, the reviewers for their meticulous evaluation of the papers and the editorial board for their continued support. We hope this collection of research articles will spark debate, inspire further exploration and foster advancements that enhance the construction industry's capacity to contribute to economic growth and societal well-being. We welcome feedback and suggestions from readers on how we may further enhance the quality and impact of the journal.

References

Bweupe, A.S., & Mwiya, B. (2024). Quality Management in Ready-Mix Concrete Production in Zambia. *Journal of Construction Business and Management*, 7(1), 1-15.

Tembo, M., Kahanji, C., & Mwanaumo, E.M. (2024). Cultivating Procurement Strategies to Manage the Tender Price Level for Public Infrastructure: A Case Study of IRCP (World Bank) Projects in Zambia. *Journal of Construction Business and Management*, 7(1), 16-33.

Sospeter, N.G., Chang'ah, A., & Rwelamila, P. (2024). Re-imagining the Factors Influencing the Choice of Project Management Tools and Techniques in Tanzanian Infrastructure Projects:

Elicitation of Practitioners' Perspectives. *Journal of Construction Business and Management*, 7(1), 34-45.

Soni, M.S.M., & Smallwood, J.J. (2024). Understanding Corruption in the South African Construction Industry. *Journal of Construction Business and Management*, 7 (1), 46-56.

Oyebode, A.O., & Daniel, E.I. (2024). Addressing the Housing Shortage Gap in Nigeria: An Exploration of the Dry Construction Method. *Journal of Construction Business and Management*, 7(1), 57-71.

JCBM (2024) 7(1) 1-15

University of Cape Town

Journal of Construction Business and Management

http://journals.uct.ac.za/index.php/jcbm

Quality Management In Ready-Mix Concrete Production In Zambia

[1]Arthur S. Bweupe and [2]Balimu Mwiyaand
[1&2]School of Engineering, Civil and Environmental Engineering Department, University Of Zambia

Received 04 January 2024; received in revised form 08 April 2024, 02 May 2024, 23 May 2024; accepted 23 May 2024
https://doi.org/10.15641/jcbm.7.1.1508

Abstract

The construction industry, a significant contributor to global economies, is projected to yield substantial economic output by 2030 of around $135 trillion. Central to construction is concrete, a widely used material. Ready-mix concrete (RMC), a specialised form of concrete, is gaining prominence due to its rapid setting and superior quality. In Zambia, the increasing demand for RMC highlights the need for stringent quality management to hedge potential structural risks. This study aimed to determine the quality management in ready-mix concrete production in Zambia. Employing a parallel convergent mixed-methods research design to achieve the objectives, qualitative data was collected through semi-structured interviews and desk study and quantitative data was gathered through a structured questionnaire and an observation checklist. The findings of the study reveal that while guidelines exist, adherence varies. Regulatory bodies for standards, engineering and construction play pivotal roles in overseeing RMC quality. However, their execution faces inconsistencies and challenges due to limited resources and a lack of sense of responsibility. Quality control practices were investigated unveiling variations in forward, immediate, and retrospective control phases. Notable trends in proper storage and equipment calibration showed a commitment to precision. Immediate control practices, encompassing sampling and non-compliance management, demonstrated both positive aspects and areas for improvement. Retrospective control showed commitment to comprehensive strength testing and minimal towards split cylinder testing and on-site slump evaluation. In the realm of quality assurance (QA), RMC facilities show substantial adherence to documented QA standard operating procedures and thorough raw material inspections. However, deficiencies in batching and mixing practices and limited adoption of modern weighing systems require improvement. The study recommends creating an industry association for collaboration, enhancing standardised practices, introducing third-party quality audits, and proposing compulsory RMC standards to boost progress in the Zambian RMC industry.

Keywords: Quality Management, Ready Mix Concrete, Observation, Desk Study, Zambia.

1. Introduction

Construction plays a distinctive role in long-term economic growth by increasing a country's physical infrastructure and providing adequate employment opportunities through its close interlinkages with other sectors (Sun *et al.*, 2013). In recent decades, the construction sector has experienced continuous growth, and it has made a significant and exceptional contribution to the growth of both the global economy as a whole and the economies of individual nations (Gizaw, 2021). Furthermore, it is projected that in this decade leading to 2030, there will be an estimated cumulative sum of $135 trillion in construction activity, propelled by exceptional levels of government economic support and the rapid advancement of major global infrastructure initiatives (Oxford Economics, 2021).

Concrete, an extremely vital component of any infrastructural establishment, is one of the most widely used construction materials worldwide. Due to its adaptability and versatility, concrete, a robust, long-lasting and endorsed building material for hundreds of years, retains its position as the most common, affordable, and essential material for the

[1] Corresponding Author
Email address: bweupearthur@gmail.com

construction of various infrastructures and it unsurprisingly makes up the greater part of structures, particularly for multi-storey buildings and infrastructure, where it contributes between 30 and 50 per cent of the entire total cost (Ravindrarajah, 2010; Naiknavare *et al*., 2018). Clearly, concrete stands out as the fundamental construction material that has significantly influenced the contemporary world, and it holds a pivotal position in constructing a sustainable future ahead serving as a cornerstone in meeting the requirements for sustainable and thriving communities by facilitating essential infrastructure, homes, and access to clean water, as well as clean and renewable energy (GCCA, 2021).

A specialised type of concrete known as ready mix concrete (RMC) produced at centralised batching plants according to the specification of the customer and delivered to the site is a preferred material due to its affordability, eco-friendliness and high strength (Shah *et al,*. 2014). As shown in a study carried out by Al-Saedi *et al*. (2019), the main advantages of RMC over site mixed concrete are its high quality, low life cycle cost, speedy production, and environmental friendliness. However, when various factors compromise RMC quality, unusable concrete is produced. As much as RMC emerges as an advantageous material in congested sites where setting up a batching plant is challenging, the absence of proper and effective quality monitoring systems in most of these batching plants adversely affects the quality of the concrete produced (Naiknavare *et al,*. 2018). According to a study by Achiso (2021), it was found that improper storage of the materials used to make concrete, the quality of the fine aggregates, the plant feed systems, the inadequate material testing facilities and labs at the plants, the use of contaminated groundwater for concrete mixing and as well as the mode of concrete transportation were the key contributing factors which affect the quality of ready-mixed concrete. In addition, material source, mix design, curing method and lack of periodic calibration of batching plants also significantly impact the quality of RMC. Furthermore, increased travel time from the batching plant to the site of placement contributes to the increase in slump value and decrease in concrete strength (Hossain and Rahman, 2013).

Following the increased popularity of RMC, there is a need to control and restrict the factors that may compromise its quality by instituting the appropriate quality management systems. This highlights the aim of this paper which is to determine the quality management of ready-mix concrete (RMC) production in Zambia. To achieve this aim, the following objectives were formulated:

- To examine existing guidelines in quality management of RMC in Zambia.
- To assess the role of regulatory bodies in the quality management of RMC in Zambia.
- To investigate the quality control and quality assurance practices in RMC production in Zambia.

2. Literature Review

2.1. Ready Mix Concrete

Ready Mix Concrete (RMC) is regarded as a specialised concrete whose components, including cement, aggregates, water, and admixtures, are all weighed at a production facility and mixed in either a central or truck mixer before being delivered to a site in plastic form, needing no additional treatment before placement and settling (Naiknavare *et al*., 2018). The use of RMC supplied as per the customer's mix design has increased recently since it sets and hardens more rapidly and is of greater quality than manually mixed in-situ concrete (Mayteekrieangkrai and Wongthatsanekorn, 2015). RMC is the preferred material in contemporary engineering and construction projects because it offers solutions to specific customer challenges and ensures product satisfaction by supplying concrete of the necessary and acceptable quality, which has an immediate impact on the structural integrity of buildings and structures (Baheti et al., 2017). Due to its strength, adaptability for diverse purposes, and also because it is made in a factory setting which allows for tight control of all manufacturing and transportation processes for fresh concrete, RMC is currently one of the most commonly used construction materials (Baheti *et al*., 2017).

2.1.1. Types of RMC

According to Biswas and Sen (2016) and Chakraborty and Farhan (2022), there are 3 types of RMC based on how various components are mixed namely transit mixed concrete, shrink-mixed concrete, and central mixed concrete:

A. Transit-mixed concrete

This is a kind of RMC also known as dry-batched concrete whose components, except for water, are weighed at a central plant and thoroughly mixed in the truck during transportation and water is only introduced to the mix right before placement on site.

B. Shrink mixed concrete

This type of concrete is partially mixed in a stationary plant mixer then a drum mixer mounted on the delivery truck completes the mixing on the way to the site. The amount of mixing to be carried out on the way is dependent on how much mixing is done at the central plant.

C. Central mixed concrete

Before being loaded into transit truck mixers for high-slump concrete or dump trucks for low-slump concrete, this type of concrete is thoroughly mixed in a central mixing facility, also known as a wet batch or premix plant The three types of RMC based on how various components are mixed are shown in Figure 1.

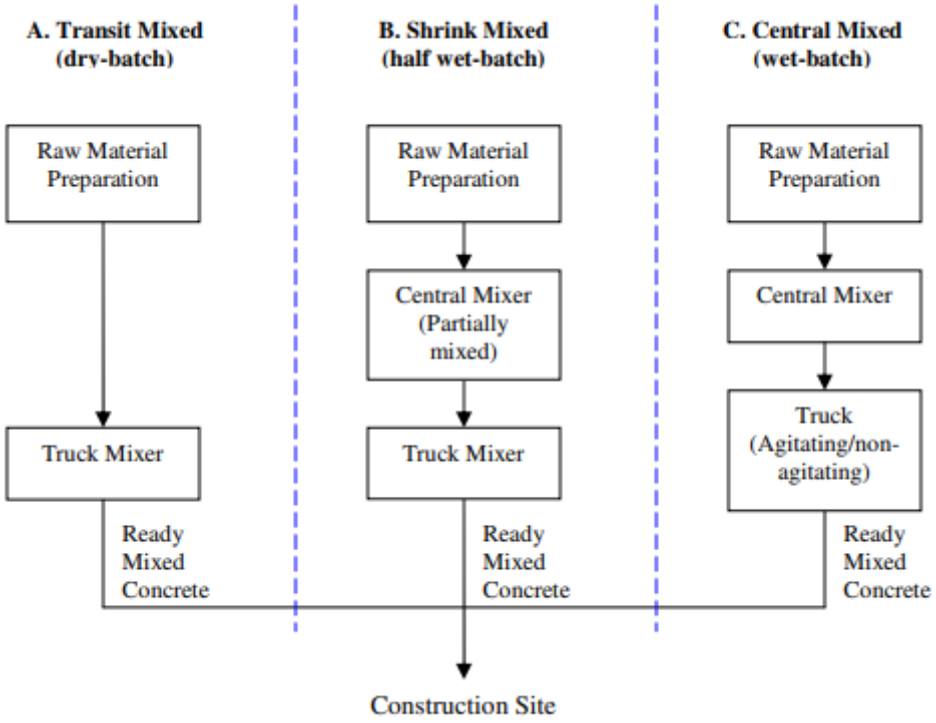

Figure 1: Types of RMC based on mixing methods. Source: Kermeli *et al*. (2013).

2.2. Quality Management of RMC

The accurate evaluation of the quality of RMC, which is presently the primary material used in construction, land development, and architecture, has a significant influence on ensuring that each stage of the production process is operating effectively and efficiently (Skrzypczak *et al*., 2021). Because RMC is normally produced in huge volumes for different uses, a tight quality management scheme should be adhered to bearing in mind the following: Material selection and storage, quality monitoring of materials, maintenance of the plant, equipment calibration, sampling of freshly made concrete, testing of RMC and analysis of test results, weight checking of loaded and unloaded trucks, material stock control and correction of reported faults and defects (Dhayanandhan and Sasikumar, 2017).

Quality control (QC) involves overseeing the characteristics of a product related to its quality, evaluating them against predetermined criteria or specifications, and implementing appropriate measures if any discrepancies arise from the established norms (Putri *et al.*, 2019). Dhayanandhan and Sasikumar (2017) described Quality control as a thorough and systematic evaluation of all aspects of the production process, starting from the procurement of materials and extending to the final delivery of the product at the designated location, to ensure that each stage of production complies with established quality standards. Effective quality control of concrete not only ensures the proper functioning of each stage of the production process but also directly affects the certification associated with factory production control as it serves as the foundation for ensuring that the production facility meets at least the necessary requirements (Skrzypczak *et al*., 2021). In line with Dhayanandhan and Sasikumar, (2017), Suryakanta (2018) and Naiknavare *et al.*, (2018), the quality control of RMC may be broken down into three parts: forward control, immediate control and retrospective control.

- Forward control is primarily concerned with the procurement of high-quality materials, their appropriate storage, quality monitoring of materials, modification of concrete mix design, calibration of equipment and maintenance of batching plant and transit mixers.
- Immediate control entails taking quick action to monitor concrete quality during

production and delivery. This includes accurate batch data reading, precise weighing, visual observation and testing of concrete during production and delivery, with an emphasis on assessing uniformity, cohesion, and workability, adjustment of water content, and finally making the necessary modifications at the plant either automatically or manually to batched quantities to account for observed, measured, or reported changes in materials or concrete qualities.

- Retrospective control primarily focuses on the procedures and processes used for quality control after concrete production. These include concrete sampling, testing, and result monitoring; truck weight checks at weighbridges; material stock control; and the identification and correction of faults.

Quality assurance (QA) on the other hand can be described as a set of pre-planned measures and organised efforts that are essential in ensuring that a product or service meets the specified quality requirements and provides sufficient assurance of its effectiveness (Achiso, 2021). Melesse, (2021) adds that the purpose of QA is to confirm that the processes, procedures, tools, and precautions in place are both present and effective, ensuring that the desired quality levels are achieved and that the resulting outcomes are of high quality. QA of RMC involves the inclusion of a quality control plan that provides a comprehensive outline of the frequency and type of inspection, testing, and sampling required to measure and regulate the different properties controlled by agency specifications (Achiso, 2021).

2.3. RMC Testing

To ensure that the quality of the concrete delivered to the customer meets the mix design specifications, RMC producers monitor the strength of their product on a daily, weekly, or monthly basis (Mohamed, 2012). According to Hossain & Rahman (2013), there are three commonly used strength tests for RMC, which include the slump test, compressive strength test, and split tensile test.

2.3.1. Slump Test

Slump testing can be viewed as a measurement of a concrete mix's resistance to shearing as it flows under its own weight (Andayani and Madenda, 2016). The most popular technique used to evaluate fresh concrete's flow characteristics such as consistency, flowability, pumpability, compactibility and workability is the slump test, which can conveniently be done on any site (Hoang and Pham, 2016; Mohan and John, 2020). The amount of time and concrete needed, the ease of operation, and the accessibility of the experimental structure all contribute to the widespread use of the slump test (Su et al., 2021). Concrete slump ranges in various applications are outlined in Table 1.

Table 1: Concrete slump ranges in various applications

Concrete mix type	Slump range (mm)	Application
Very dry	0 - 25	Road construction.
Low workability	10 - 40	Foundation with light reinforcement.
Medium workability	50 - 90	Normal reinforced concrete with little vibration.
High workability	> 100	Normal reinforced concrete

Source: Suvash, (2011).

During the slump test, three different types of slump could transpire: a true slump which refers to a uniform drop of the concrete mass without disintegration, a shear slump which donates a concrete mix that lacks cohesiveness and may segregate and bleed negatively affecting the concrete's durability and lastly, a collapse slump indicates that a concrete mix is excessively wet (Singh, 2010). Figure 2 graphically presents the 3 types of slumps:

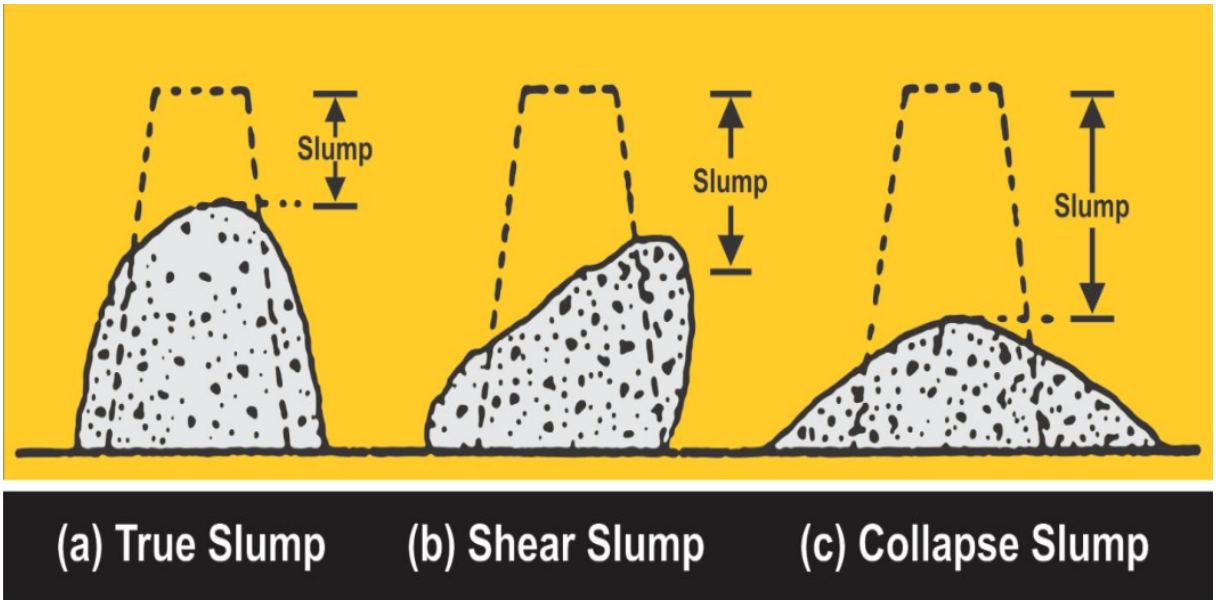

Figure 2: Types of Concrete Slump. Source: (Neville and Brooks (2010).

2.3.2. Compressive test

To meet the design specifications of a structure, concrete mixtures can be designed to have a wide range of mechanical and durability characteristics (NRMCA, 2014). Because it is the primary determinant of concrete quality, Engineers frequently consider the concrete's compressive strength as a performance factor when designing structures (NRMCA, 2014; Hassoun and Al-Manaseer, 2015). This compressive strength of concrete is measured using the compressive strength test which is used to evaluate the strength of hardened concrete and demonstrates its measure of resistance (Kumar and Tegar, 2018).

2.3.3. Split Tensile Test

Concrete cannot withstand extremely high tensile stresses because of its brittleness, which is crucial when considering cracking, shear, and torsional issues (Hassoun and Al-Manaseer, 2015). Due to small misalignment and stress concentrations in the gripping devices, direct tension testing is unreliable in estimating the tensile strength of concrete. Therefore, an indirect test commonly known as the Brazilian test, in the form of splitting a 150 x 300mm concrete cylinder, is widely used (Denneman *et al.*, 2011; Hassoun and Al-Manaseer, 2015). However, Denneman *et al.* (2011) point out that when compared to a direct tension test, the splitting tensile test has its drawback of not providing adequate information on the material's post-crack behaviour but only measures the tensile strength.

2.4. Cement and Concrete Production In Zambia

Fourteen (14) cement manufacturing companies in Zambia of which eight (8) are in the capital city have played a significant role in economic growth by providing easy access to cement for property developers. However, only three of them - Dangote Quarries Zambia Limited, Lafarge Cement, and Zambezi Portland Cement, have emerged as the primary contributors to the construction sector, producing a total of 1,956,519 metric tonnes of cement in 2016 (Tembo, 2017). Since the 2000s, the cement sector in Zambia has experienced substantial growth, with output increasing from approximately 340,614 tonnes in 2000 to more than 1,500,000 tonnes in 2012, as a result of sustained high demand for residential, commercial, and public infrastructure projects throughout the country (UNCTAD, 2020).

Quality management of cement and concrete products in Zambia is mainly managed by the Zambia Bureau of Standards (ZABS), in collaboration with diverse stakeholders such as government departments, industry representatives, academic institutions, regulators, consumer associations, and non-governmental organisations, through the development and implementation of two standards, namely ZS - 802 and ZS - 803. These standards are responsible for regulating the nationwide testing and sampling procedures for concrete (ZABS, 2013a; ZABS, 2013b).

Standardisation plays a crucial role in the construction sector for various reasons. It minimises the necessity for extensive on-site inventory, facilitates effective communication regarding materials, enables comprehensive inventory analysis, strengthens quality control measures by precisely outlining requirements, and simplifies the identification of dependable suppliers through the adoption of national standards (Achiso, 2021). Both legal mandates and industry norms establish well-defined testing protocols and quality assurance

standards that cover every stage of the production process of RMC, including its delivery to construction sites and these guidelines emphasise the importance of adhering to technical specifications to ensure the efficient execution and successful completion of construction projects (Skrzypczak et al., 2021). In this regard, ZABS, a specialised organisation dedicated to standardisation, quality assurance, metrology, and testing offers training and advisory services in quality management, provides expertise in quality assurance and quality control, and develops implementation schemes for various industries like construction. Furthermore, ZABS facilitates material examination and testing by organising suitable facilities (ISO, 2022).

3. Research Methodology

3.1. Research Approach and Design

This study employed a mixed-method approach enhancing the conclusiveness, precision and reliability of findings by integrating two different methods in a manner that leverages the advantages of qualitative methods to compensate for the limitations of quantitative methods, and vice versa (Plano and Ivankova 2016; Dawadi et al., 2021). Furthermore, this study adopted a parallel convergent mixed-methods research design. In a convergent design, combining both datasets allows researchers to achieve a comprehensive understanding that surpasses what can be obtained from either quantitative or qualitative results alone (Dawadi et al., 2021). Therefore, the design allowed for a comprehensive examination of the existing guidelines, the role of regulatory bodies and an investigation of the quality control and assurance practices in the RMC industry in Zambia considering both numerical data and in-depth insights from key stakeholders.

3.2. Population and Sampling Technique

The targeted population comprised seven out of eight RMC plants found in Lusaka, selected through a non-probability purposive sampling technique to obtain the most valuable information for the study. The study also included key industry regulatory bodies namely the Engineering Institution of Zambia (EIZ), the National Council for Construction (NCC), the Zambia Bureau of Standards (ZABS), and the Zambia Compulsory Standards Agency (ZCSA).

3.3. Data Collection and Analysis

Qualitative data was obtained through desk study and semi-structured interviews. Document analysis of existing RMC quality management guidelines was carried out followed by semi-structured interviews which were conducted with key personnel from different regulatory bodies to gain insight into their unique role and involvement in the quality management of RMC production in Zambia.

Quantitative data on the other hand was acquired through an observation checklist. Direct observation as a data collection technique to assess the quality control and quality assurance practices of the Zambian RMC industry was preferred. According to Kawulich (2012), direct observation entails the act of carefully watching and examining objects or individuals in a specific environment without actively engaging or interacting with them. All three aspects of quality control namely forward control, immediate control and retrospective control were observed. Under forward control, material storage, quality monitoring and inspection, and calibration and maintenance of plant equipment were observed. concrete sampling process, testing procedures and non-conformance management were the immediate control aspects that were closely observed. Lastly, concrete sampling and testing post-production, truck weight checks, delivery time tracking and concrete slump testing on site upon delivery were observed as part of the retrospective control. With regards to quality assurance, aspects ranging from documentation and procedure, and raw material inspection to batching and mixing processes were observed.

The quantitative data collected from the observation checklist at the targeted RMC plants was analysed using Excel statistical software. Descriptive statistics, such as means, frequencies, and percentages, were calculated to evaluate general quality management in RMC production in Zambia.

3.4. Limitations of the Study

Acknowledging the Hawthorne effect in this study is essential since the behaviour of workers in the observed RMC plants might have deviated from their typical tendencies owing to the awareness of being observed, potentially influencing the outcomes of the study. Additionally, it is crucial to recognise the possibility of biases in the collected data, as stakeholders from regulatory bodies interviewed might have provided information that reflects positively on their organisation.

3.5. Ethical Considerations

Ethical approval from the University of Zambia Ethics Committee known as the Natural and Applied Sciences Research Ethics Committee (NASREC) was obtained. All information gathered during the study was used solely for academic purposes and confidentiality was maintained. Voluntary participation of all participants was emphasised too.

4. Results and Discussion

4.1. Existing Guidelines on Quality Management of RMC

The study identified the existing standards employed in Zambia for the quality management of RMC as shown in Table 2.

Table 2: Existing guidelines on quality management of RMC in Zambia.

Standards No.	Standards Name	Standard Scope
C94/C94M - 17a	Standard Specification for Ready-Mixed Concrete	The specification pertains to freshly mixed and unhardened ready-mixed concrete delivered to a buyer as per the specified conditions.
ZS ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens	The specification outlines the method for assessing the compressive strength of cylindrical concrete specimens, encompassing both moulded cylinders and drilled cores.
ZS ASTM C33	Standard Specification for Concrete Aggregates	The specification outlines the criteria for grading and quality of fine and coarse aggregate intended for utilisation in concrete.
ZS 802 - 1	Concrete Tests Part 1: Mixing Fresh Concrete in the Laboratory	The Standard provides guidelines for accurately batching and mixing concrete in controlled laboratory conditions for quality assessment and practical application on construction sites.
ZS 803 - 2	Concrete Tests Part 2: Sampling Of Freshly Mixed Concrete	The standard outlines the procedures for obtaining samples of fresh concrete, whether on-site or in a laboratory, and describes the subsequent testing methods used to determine if the concrete meets the criteria set by the relevant standard(s).
ZS EN 197	Cement Part 1: Composition, Specifications and Conformity Criteria for Common Cements	The standard offers clear and specific definitions for the constituents of cement and outlines their mechanical, physical, and chemical prerequisites. Additionally, it establishes criteria for conformity and sets forth durability requirements.
ZS EN 197	Cement - Part 2: Assessment and verification of constancy of performance	The standard specifies the scheme for the assessment and verification of constancy of performance (AVCP) of cements, including certification of constancy of performance.
ZS EN 196	Methods of testing cement - Part 1: Determination of strength	The standard outlines the procedure for determining the compressive strength of cement mortar and, if desired, the flexural strength as well.
ZS EN 196	Method of testing cement - Part 2: Chemical analysis of cement	The standard specifies the methods for the chemical analysis of cement.

4.2. The Role of Regulatory Bodies

4.2.1 Engineering Institution of Zambia (EIZ)

The interview established the role and mandate of EIZ as stipulated in the Engineering Institution of Zambia Act of 2010. Concerning the quality management of RMC in Zambia, the institution is mandated to register both individuals and corporate organisations and units engaged in RMC production. Responded A said, *''We as EIZ are mandated to offer quality assurance by ensuring engineering organisations and units are registered and that their workforce is also registered to practise engineering in Zambia.''* Additionally, it was confirmed that the Institution conducts unannounced visits to different RMC plants quarterly to verify the compliance of both companies and their workforce. When such surprise inspections reveal any discrepancies, the non-compliant company or individual is subjected to the relevant provisions in sections 18 and 15 of the EIZ Act respectively.

4.2.2 National Council for Construction (NCC)

During the interview, it was revealed that according to the National Council for Construction Act No. 10 of 2020, NCC has been assigned the responsibility of registering and regulating the supply of building materials, including ready-mix concrete. As part of its regulatory role, NCC conducts regular quality control checks on concrete works at random construction projects throughout the country. Furthermore, NCC allocates funds to a joint committee with the Zambia Bureau of Standards (ZABS) to adopt, adapt, or update all construction-related standards, including those pertaining to concrete and its components. On the other hand, the council is also supposed to inspect production plants and the sites where various building materials are sourced. However, two of the three respondents (66%) from NCC reported that due to financial constraints and a delay in receiving a Statutory Instrument (SI) from the parent Ministry, that would strengthen their enforcement capabilities, no inspections are currently being carried out. Respondent B stated, "*Inspecting production sites of building materials, whether on construction sites or company premises, is within our mandate, but insufficient funding prevents us from doing so.*" Respondent C added, "*We are facing challenges in fully implementing the registration and regulation of suppliers of building materials, mainly because of an SI pending approval at the ministry for the past 4 years or so.*"

4.2.3 Zambia Bureau of Standards (ZABS)

ZABS plays a crucial role in managing the quality of Ready-Mix Concrete (RMC) by evaluating RMC and cement suppliers' production systems against internationally recognized standards. Additionally, ZABS has the authority to grant voluntary licences and trademarks to suppliers of different cement and RMC brands, serving as a quality indicator for customers. Once annually, ZABS conducts surprise inspections on cement suppliers, examining cement's chemical composition, flexural and compressive strength of specimens, as well as storage and transportation practices to the market. Furthermore, market surveillance surveys are carried out in response to customer complaints, and in such cases, ZABS inspects the affected brand multiple times within the year. If any supplier is found to be non-compliant, a Non-Conformity Report (NCR) is issued and 60 days is given to rectify the non-compliance, failing to which their licence is revoked by ZABS.

4.2.4 Zambia Compulsory Standards Agency (ZCSA)

In the Zambian construction industry, ZCSA plays a crucial role in managing the quality of Ready-Mix Concrete (RMC) supplied. Their responsibility involves conducting mandatory quality control inspections at cement production facilities. These inspections occur quarterly for each facility, and only those meeting internationally acceptable standards are granted permits to supply the market. However, facilities found non-compliant with these standards face repercussions. Non-compliance falls into three categories: critical, which results in a complete shutdown of plant production, major, and minor. The latter two categories offer the facilities an opportunity to rectify the identified issues within a month.

4.3. Quality Control and Quality Assurance Practices

Quality control (QC) and quality assurance (QA) procedures from seven (7) out of eight (8) RMC plants in Lusaka were observed and documented.

4.3.1 Quality Control

This study examined three dimensions of quality control: forward control, immediate control, and retrospective control. The results of the observation shows that **d**uring the forward control assessment, the proper storage and labelling of the concrete components, including fine and coarse aggregates, cement, water, and admixtures, were considered as the proactive control measures. Among all the plants observed, two (28.6%) exhibited correct storage and labelling for fine aggregates and an equal percentage for coarse aggregates. For cement, this figure was three (42.9%), while for water, it was one (14.3%). Remarkably, all seven plants (100%) demonstrated proper storage and labelling of admixtures. The results are summarised in Figure 3:

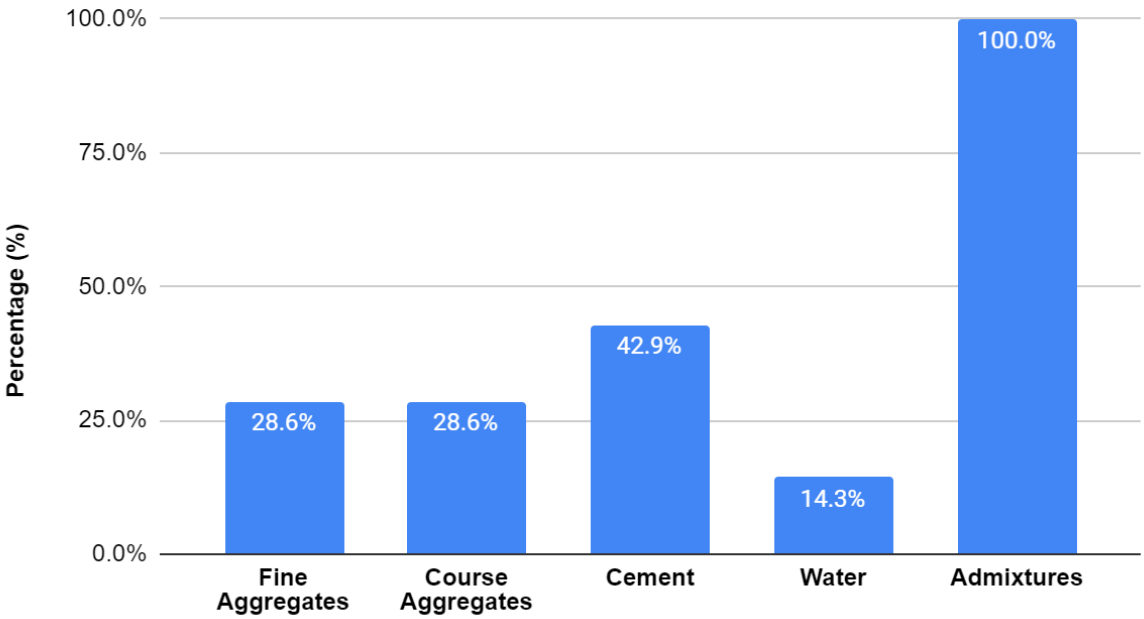

Figure 3: Forward control of raw material storage.

Additionally, regular calibration of RMC plant equipment was also observed as part of the forward control assessment. Among all plants, five (71.4%) regularly calibrated their equipment while two (28.6%) did not. Figure 4 depicts a summary of the results.

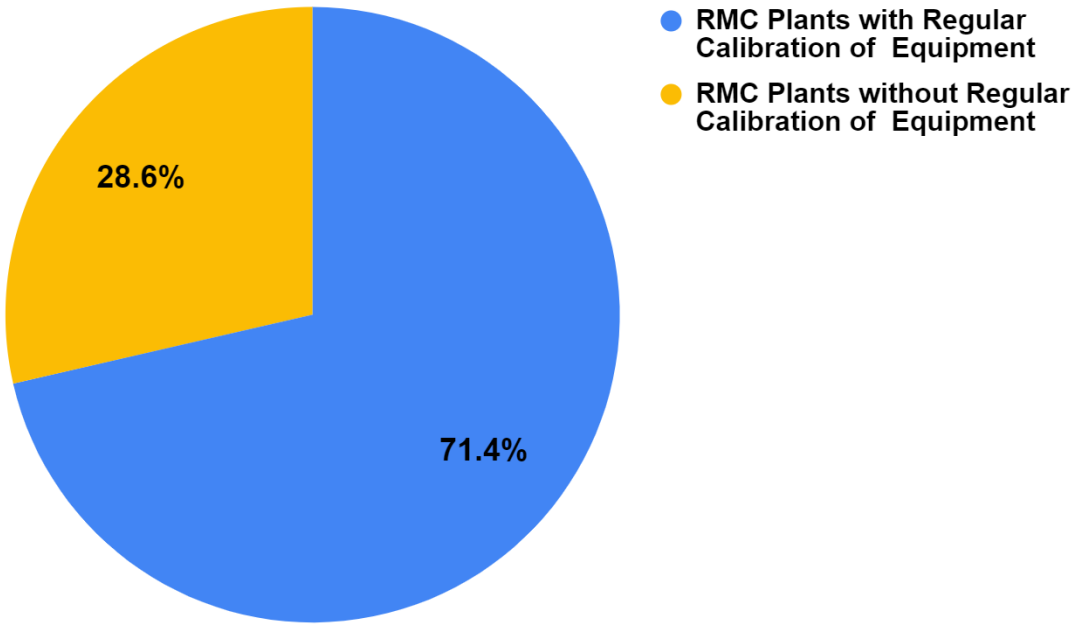

Figure 4: Forward control - calibration of RMC plant equipment.

Under the assessment of immediate control, the observation of concrete sampling, testing, and non-compliance management took place. The findings revealed that out of the total RMC plants surveyed, merely two (28.6%) had implemented a sampling plan, three (42.9%) followed regular sampling intervals, and four (57.1%) appropriately labelled their concrete samples before storage. Additionally, it was observed that only two (28.6%) of the plants had a non-compliance management system in place, one (14.3%) had a procedure for investigating non-compliance, and two (28.6%) had formulated corrective action plans. On a positive note, a majority of plants, six (85.7%), had well-established procedures for testing concrete workability. Figure 5 summarises these findings.

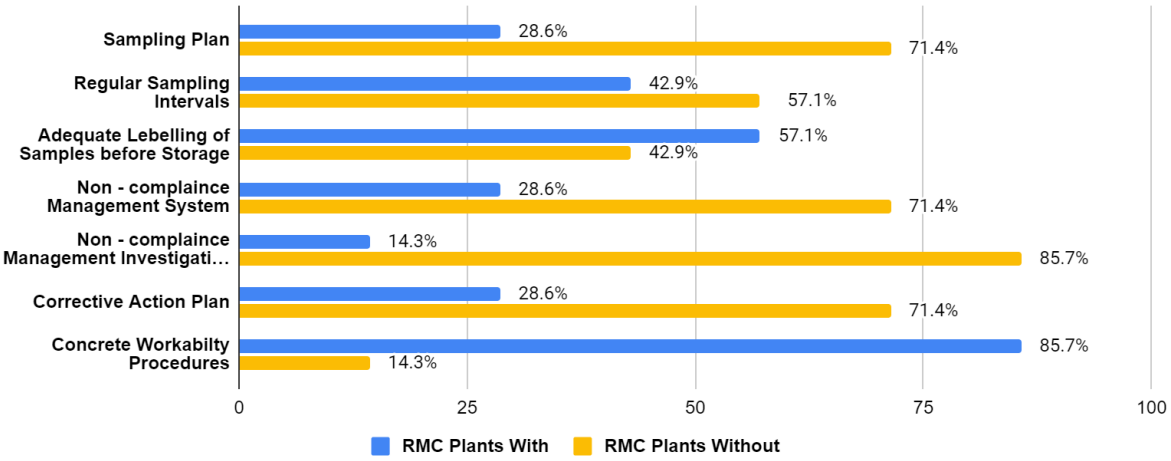

Figure 5: Immediate control - concrete sampling, testing and non-compliance management.

Several aspects were observed while evaluating retrospective control in various RMC plants. These aspects included examining whether concrete tests such as the compressive strength test, slip tensile test and on-site simple test were being carried out. It was observed that each of the RMC facilities conducted compressive strength tests in their laboratories. On the other hand, only two (28.6%) of them carried out slip tensile tests, while five (71.4%) conducted on-site slump tests, even when not specifically requested by clients. Furthermore, the observation also involved monitoring truck weight checking and concrete delivery times. The findings indicate that among all observed RMC plants, four (57.1%) performed truck weight checks while three (42.9%) kept track of the delivery time for concrete to their respective customers. A summarised representation of these findings can be found in Figure 6 below:

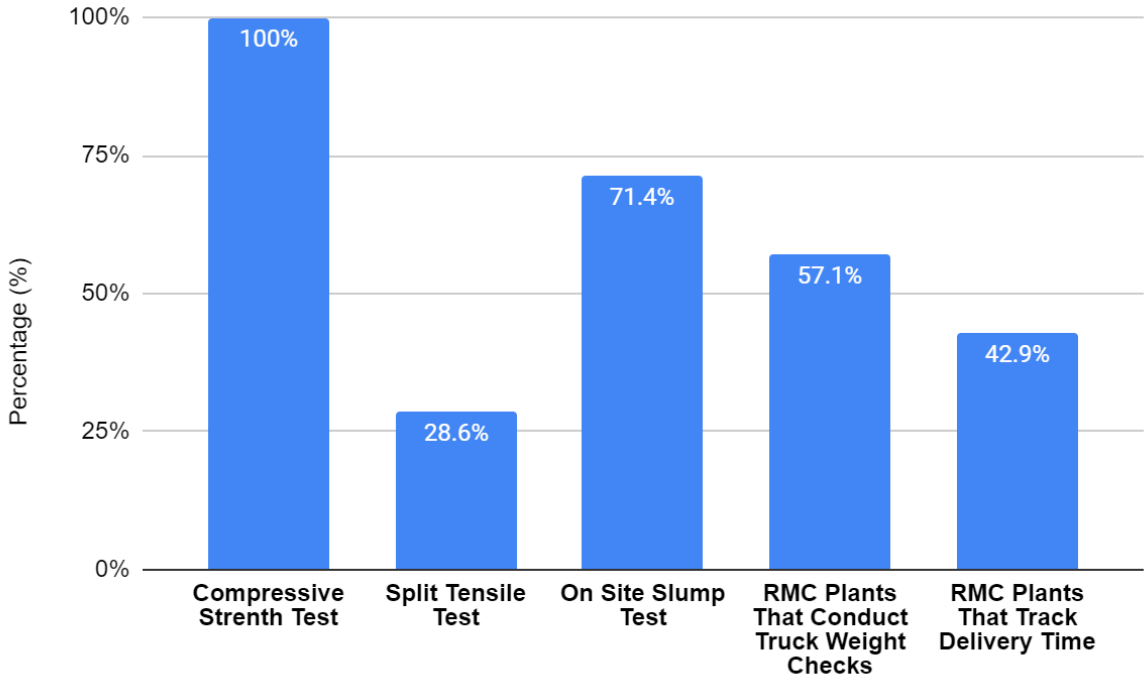

Figure 6: Retrospective control - concrete testing, truck weight checks and delivery Time tracking.

4.3.2 Quality Assurance

The three main aspects of quality assurance that were observed included documentation of QA Standard Operating Procedures (SOPs), quality monitoring and inspection of raw materials, and evaluation of batching and mixing equipment of the various RMC plants. The findings are outlined below:

With regards to the documentation of standard operating procedures, out of the RMC plants under observation, the majority, six (85.7%) of them, had well-defined QA standard operating procedures documented, while a minority, only one (14.3%), lacked any such documentation. Figure 7 provides a visual representation of these findings.

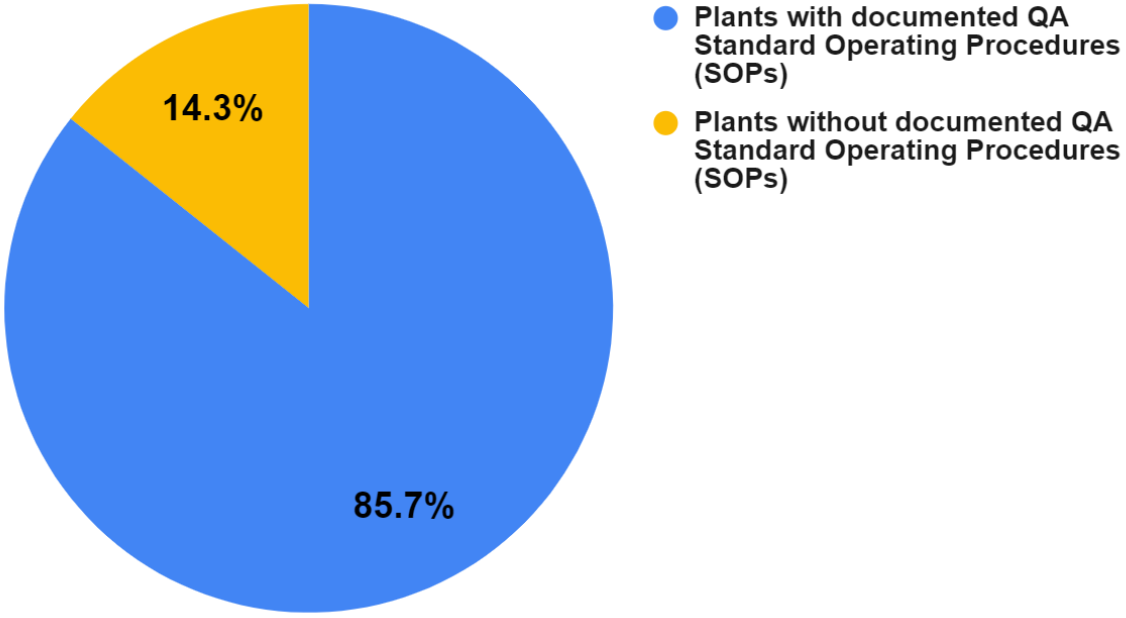

Figure 7: Documentation of QA standard operating procedures.

Regarding the monitoring and inspection of the quality of raw materials, findings revealed that two (28.6%) of the plants monitored and inspected the quality of fine aggregates, while three (42.9%) performed the same for coarse aggregates. Additionally, five (71.4%) of the plants inspected and monitored the quality of cement while two (28.6%) carried out quality checks on water. Remarkably, six (85.7%) monitored the quality of admixtures. A summary of these findings is illustrated in Figure 8.

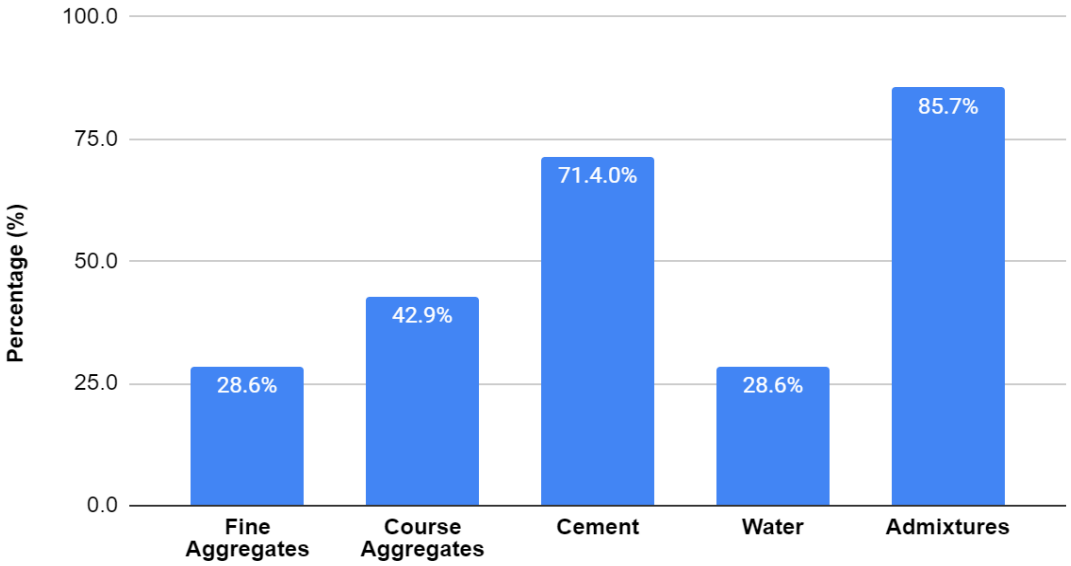

Figure 8: Quality monitoring and inspection of raw materials.

In the production of high-quality concrete, the processes of batching and mixing play a vital role. Among the RMC plants studied it was found that, as shown in Figure 9, two (28.6%) plants had established SOPs for batching and mixing, while three (42.9%) plants utilised modern weighing systems in their operations.

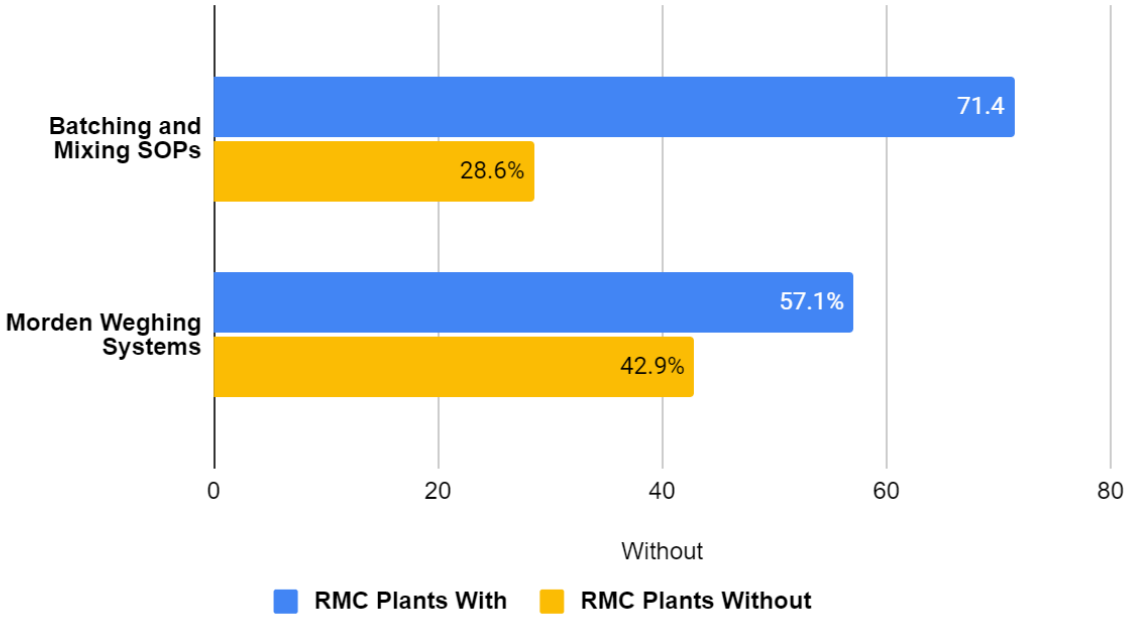

Figure 9: RMC batching and mixing.

5.Discussion

5.1. Existing Guidelines

Despite the existence of established standards and guidelines, some of which have been adopted from globally recognised standards, there is an essential requirement for effective implementation to guarantee the proficient management of RMC quality. Regrettably, within Zambia's regulatory framework, only ZS EN 196 and ZS EN 197 are mandatory, and these exclusively relate to cement, which is just one of the raw components necessary for RMC production. This selective application of guidelines raises questions regarding the potential implications for overall RMC quality. The absence of compulsory adherence to guidelines for crucial concrete components could create variations in the quality of the final product. This variability might arise due to differential interpretations of quality requirements, resulting in a lack of standardised practices across the industry. Another challenge faced by African standardisation bodies as noted by Schmidt et al. (2023) is the lack of increased awareness of relevant parameters affecting the sustainability of the adopted standards. This is evident in the Zambian setup where most of the standards were simply adopted with little or in some cases no adequate review to accommodate more local attributes and parameters to the standards.

5.2. The Role of Regulatory Bodies

Regulatory bodies are pivotal in promoting public safety and quality in the construction industry (Zakharoff, 2023). Notably, it was found that regulatory bodies such as EIZ, NCC, ZABS, and ZCSA have clearly defined mandates and roles concerning the management of RMC quality in Zambia. However, executing these mandates and roles has been inadequate due to the absence of a sense of responsibility. This has resulted in RMC producers operating rather independently, with minimal engagement from these regulatory bodies. As Achiso (2021) pointed out, the concrete industry suffers from regulatory bodies not effectively fulfilling their designated duties, primarily due to a lack of accountability. Additionally, another obstacle confronting regulatory bodies in the African concrete sector in their quest for effective quality control is the absence of enforceable standards, coupled with inadequate surveillance systems, leaving room for potential safety hazards such as building collapses to occur without proper oversight (Schmidt *et al*., 2018). Due to the absence of strict and enforceable standards within the Zambian RMC space, the regulatory bodies risk becoming redundant in overseeing RMC quality management.

5.3. QC and QA Practices

Variations observed in both QC and QA practices in the Zambian RMC industry risk the supply of concrete to the market of inconsistent quality. Issues such as effective storage of raw materials enhance plant productivity, the overall operational efficiency, and contribute to improved quality (Achiso, 2021). As noted, Zambian producers of RMC must prioritise the appropriate storage of essential raw materials, aggregates, cement, and water. Additionally, according to Hossain and Rahman (2013), the absence of regular calibration for batching plants has a notable effect on the quality of produced RMC. It's praiseworthy that most RMC

plants in Zambia are presently conducting routine equipment calibration. Nevertheless, the remaining minority must do the same to enhance the overall management of RMC quality.

6. Conclusions

The study has unveiled a landscape in which guidelines governing the quality management of RMC in Zambia exist, though with notable gaps in mandatory adherence. While standards such as ZS EN 196 and ZS EN 197 regarding cement are obligatory, crucial guidelines concerning other concrete components like fine aggregates, coarse aggregates, water, and admixtures remain optional, granting RMC producers discretionary control over their utilisation.

In terms of industry regulatory oversight, the roles of bodies like EIZ, NCC, ZABS, and ZCSA collectively aim to uphold RMC quality standards. However, the study reveals challenges stemming from inconsistent execution and a lack of coordination, attributed partly to a sense of irresponsibility and constrained funding.

The study also looked into quality control in Zambia's RMC industry. Forward control assessments show that 71.4% of plants engage in equipment calibration, but also reveal differences in storage and labelling adherence. Immediate control aspects indicate mixed implementation levels, pointing out areas like sampling plans and non-compliance management that need improvement. Retrospective control assessments demonstrate a commitment to strength tests but suggest enhancing practices such as split tensile tests. Concerning quality assurance, the study concluded that a significant number of RMC facilities meticulously record QA standard operating procedures, thereby conforming to industry standards and ensuring consistent and reliable RMC production. Additionally, a substantial majority of RMC plants conduct thorough quality inspections of their raw materials. However, the study uncovers a concerning aspect: a portion of the plants lacks standard operating procedures for batching and mixing, compounded by a limited adoption of modern weighing systems.

7. Recommendations

To enhance the management of RMC quality in Zambia, the following are the recommendations.

- **Industry Collaboration for Best Practices:** There is a need to establish an industry association that brings together RMC producers, regulatory bodies, experts, and academia to collaborate on setting and updating industry best practices regularly.
- **Enhancing Standardisation of Practices:** With help from the establishment of an industry association, there should be an effort to strengthen and impose standardised practices.
- **Quality Audits:** The government through industry regulatory bodies should consider conducting periodic third-party quality audits on RMC plants to assess their adherence to established standards and procedures.
- **Compulsory RMC Standards:** It is essential to consider establishing C94/C94M - 17a - Standard Specification for Ready-Mixed Concrete as a mandatory industry standard to ensure consistent adherence to globally recognised concrete quality standards.

References

Achiso, M. (2021). *Study on ready-mixed concrete quality control practice in Addis Ababa* (Unpublished MSc. dissertation). Addis Ababa University, Addis Ababa Institute of Technology of Ethiopia.

Al-Saedi, A., Paslawski, J., & Nowostarki, P. (2019). Quality management to continuous improvements in process of ready mix concrete production. *IOP Conference Series: Materials Science and Engineering, 518*, 022019. https://doi.org/10.1088/1757-899X/518/2/022019

Andayani, R., & Madenda, S. (2016). Concrete slump classification using GLCM feature extraction. *Advanced Science, Engineering and Medicine, 8*(10), 800-803. https://doi.org/10.1166/asem.2016.1934

Baheti, V., More, A. B., Bhosale, D. B., & Shinde, P. (2017). Risk management technique of ready mix concrete plants. *International Research Journal of Engineering and Technology, 4*(6), 2701-2706.

Chakraborty, P., & Farhan, M. (2022). Study on ready-mix concrete, including a survey and experiment in the context of Bangladesh. *6th International Conference on Civil Engineering for Sustainable Development*, 10-12 Feb., Khulna.

Dawadi, S., Shrestha, S., & Giri, R. A. (2021). Mixed-methods research: A discussion on its types, challenges, and criticisms. *Journal of Practical Studies in Education, 2*(2), 25-36. https://doi.org/10.46809/jpse.v2i2.20

Denneman, E., Kearsley, E. P., & Visser, A. T. (2011). Splitting tensile test for fibre reinforced

concrete. *Materials and Structures, 44,* 1441-1449. https://doi.org/10.1617/S11527-011-9709-X

Dhayanandhan, B. V., & Sasikumar, M. (2017). Quality control and management practice in RMC. *International Journal of Engineering Technology, Management and Applied Sciences, 5*(3), 438-442. ISSN 2349-4476.

EPA. (2007). *Guidance for preparing standard operating procedures (SOPs)*. Washington: EPA.

Gizaw, G. (2021). The role of international construction for the development of economy and the challenges involved. *International Journal of Engineering Science and Computing, 11*(2), 27635-27652.

Hassoun, M. N., & Al-Manaseer, A. (2015). *Structural concrete: Theory and design* (6th ed.). John Wiley & Sons.

Hoang, N., & Pham, A. (2016). Estimating concrete workability based on slump test with least squares support vector regression. *Journal of Construction Engineering*, 1-8. https://doi.org/10.1155/2016/5089683

Hossain, A. S. M., & Rahman, M. (2013). Study on ready-mix concrete with survey and experiments in the context of Bangladesh. *Journal of Science and Technology, 4*(1).

Kawulich, B. (2012). *Collecting data through observation*. McGraw Hill.

Kermeli, K., Worrell, E., & Galitsky, C. (2013). *Energy efficiency improvement and cost saving opportunities for the concrete industry: An energy star guide of energy and plant managers*. United States Environmental Protection Agency.

Kumar, R., & Tegar, J. P. (2018). Critical analysis of properties of ready mix concrete with site mix concrete of smart road project. *International Research Journal of Engineering and Technology, 5*(6), 1734-1739. e-ISSN: 2395-0056.

Mayteekrieangkrai, N., & Wongthatsanekorn, W. (2015). Optimized ready mixed concrete truck scheduling for uncertain factors using bee algorithm. *Songklanakarin Journal of Science and Technology, 37*(2), 221-230.

Melesse, K. (2021). *Assessments of quality management practices in ready mix concrete supplier: The case of Dugda Construction Plc* (Unpublished MA dissertation). St. Mary's University.

Mohamed, A. (2012). On the use of the basic quality tools for the improvement of the construction industry: A case study of a ready mix concrete production process. *International Journal of Civil & Environmental Engineering, 12*(5), 31-38.

Mohan, M., & John, E. (2020). Study on slump retention of ready-mix concrete: A review. *International Research Journal of Engineering and Technology, 7*(7).

Naiknavare, H., Deshpande, S., & Padhye, R. D. (2018). Model chart of quality control process for ready mixed concrete plants. *Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, 50-54.

Neville, A. M., & Brooks, J. J. (2010). *Concrete technology* (2nd ed.). Longman Group U K Limited.

NRMCA. (2014). *CIP 35 - Testing compressive strength of concrete*. Alexandria: NRMCA.

Oxford Economics. (2021). *Future of construction: A global forecast for construction to 2030*. New York: Marsh LLC.

Plano, C. V. L., & Ivankova, N. V. (2016). *Mixed methods research: A guide to the field*. Sage Publications. https://doi.org/10.4135/9781483398341

Project Management Institute. (2017). *A guide to the project management body of knowledge* (6th ed.). Project Management Institute Inc.

Putri, B. A. D., Qurtubi, Handayani, D. (2019). Analysis of product quality control using six sigma method. *IOP Conference Series: Materials Science and Engineering, 697,* 012005. https://doi.org/10.1088/1757-899X/697/1/012005

Ravindrarajah, R. S. (2010). Concrete for sustainable construction. In Advances in Concrete: An Asian Perspective, Proceedings of the 3rd Asian Conference on Ecstasy in Concrete (ACECON) (pp. 135-153). 05-09 Dec., Madras.

Schmidt, W., Kanjee, J., Motukwa, G., Olonade, K., & Dodoo, A. (2023). A snapshot review of future-oriented standards for cement, admixtures, and concrete: How Africa can spearhead the implementation of green urban construction materials. *MRS Advances, 8*, 557-565. https://doi.org/10.1557/s43580-023-00563-9

Schmidt, W., Ngassam, I., Breitschaft, G., & Virchow, S. (2018). Challenges of the growing African cement market - environmental issues, regulative framework, and quality infrastructure requirements. *2nd International Congress on Materials & Structural Stability*, 1-8. https://doi.org/10.1051/matecconf/201814901014

Shah, A., Pitroda, J., & Bhavsar, J. (2014). Ready mix concrete: Economic and qualitative growth for construction industry. In *National Conference: Trends and Challenges of Civil Engineering in Today's Transforming World* (pp. 24-24). Umrakh: Patel Institute Of Technology, Civil Engineering Department.

Singh, K. (2010). What are the differences between shear slump and collapse slump in slump test. [Online]. Retrieved from https://bit.ly/46IStwG (Accessed 13 March 2024).

Su, C., Zheng, X., Xiong, L., & Zhao, W. (2021). Research on concrete slump based on discrete element method. *Journal of Physics: Conference Series, 1952,* 042078. https://doi.org/10.1088/1742-6596/1952/4/042078

Sun, Y., Mitra, P., & Simone, A. (2013). The driving force behind the boom in construction in Europe. *IMF Working Paper*. https://doi.org/10.5089/9781484392485.001

Suvash, P. C. (2011). *Mechanical behaviour and durability performance of concrete containing recycled concrete aggregate* (MSc. Thesis). University of Stellenbosch. [Online]. Retrieved from http://scholar.sun.ac.za/ (Accessed 13 March 2024).

UNCTAD. (2018). Summary of the cement cartel case in South and Central Africa: The Zambian experience. [Online]. Retrieved from https://bit.ly/4dBMw6Y (Accessed 13 March 2024).

ZABS. (2013a). Concrete tests. Part 1: Mixing fresh concrete in the laboratory. *ZS 802-1: 2013 ICS 75.200*. Lusaka: ZABS.

ZABS. (2013b). Concrete tests. Part 2: Sampling of freshly mixed concrete. *ZS 803-2: 2013 ICS 75.200*. Lusaka: ZABS.

Zakharoff, S. (2023). The importance of stringent regulatory oversight in the construction industry. [Online]. Retrieved from https://capetown.today/the-importance-of-stringent-regulatory-oversight-in-the-construction-industry/ (Accessed 22 March 2024).

JCBM (2024) 7(2) 16-33

University of Cape Town

Journal of Construction Business and Management

http://journals.uct.ac.za/index.php/jcbm

Cultivating Procurement Strategies to Manage the Tender Price Level for Public Infrastructure: A Case Study of IRCP (World Bank) Projects in Zambia

[1]Moffat Tembo, [2]Charles Kahanji and [3]Erastus Misheng'u Mwanaumo
[2]Department of Civil and Environmental Engineering The University of Zambia, P.O. Box 50235, Great East Road Campus
[3]UNISA, College of Science, Engineering and Technology

Received 20 June 2023; received in revised form 24 July 2023, 08 August 2023, 10 August 2023, 25 February 2024 , 04 March 2024, 19 April 2024 and 02 June 2024; accepted 02 June 2024
https://doi.org/10.15641/jcbm.7.1.1380

Abstract

Public infrastructure-based clients implement extant procurement strategies without carefully evaluating particular requirements to select and adapt the most appropriate practices that cultivate the best and most practical benefits of a chosen procurement strategy. The study explored procurement strategies for managing and optimizing construction tender-price levels. The study is an exploratory case study utilizing a desktop review of numerous publications, public domain reports, and person-to-person interviews. The choice of methodology corresponds to the specific nature of the research environment and phenomena characterization of the lack of detailed primary research. The research involves a robust examination of documents and trend analysis of public procurement. It results from extensive extant literature, nine case study packages of improved rural connectivity projects (IRCP), and 21 expert interviews. Improved rural connectivity project (IRCP) is a World Bank-funded project for improving Zambia's rural road accessibility and strengthening institutional capacity. Eight fundamental characteristics related to a successful procurement strategy identified are cash flow assurance, guaranteed payments, and completeness of designs. Other characteristics include level and type of competition, contractor's breakeven point, adopted procurement process (work packaging), nature of government support, and protecting market share. The study further identifies central areas for developing a successful and responsive procurement strategy: procurement planning, preferential procurement policy (protectionism), and establishing differential procurement laws. These findings form an appropriate basis for developing relevant procurement practices that improve a procurement strategy for managing construction bid prices. The study indicates the possibility of further exploiting the potential of current procurement strategies for managing construction prices by suggesting a link between poor tender-price management and a high occurrence of procurement-related lapses. The findings highlight gaps only identifiable in tender-price management studies when taking a client perspective and considering the procurement context. This study assists to develop procurement strategies that enhance the chance of deriving value for money while maintain reasonable price levels.

Keywords: construction, construction tender price, procurement strategy, public projects

1. Introduction

All procurement methods aim to obtain value for money and promote private sector participation through the maximum possible competition (Public Procurement Act, No. 8 of 2020). According to the Zambia Public Procurement Regulations (2022), public procurement governance abides by

[1]Corresponding Author
Email address: tembomoffat@yahoo.com

fundamental principles, such as transparency, competition, economy, efficiency, fairness, value for money, and accountability. However, the prevailing procurement practices face criticism due to the "resulting adversarial relationships between the involved parties" and the construction processes' increased complexity and involvedness (Lahdenperä, 2014: p.2). There has been a comprehensive overall development of alternative, unconventional procurement methods "categorized by management of the interaction between the design and construction of the project" (Turina et al, 2008, p.2). By introducing unanticipated cost uncertainties, selecting and utilizing inappropriate procurement approaches can impact construction prices.

Consequently, providing clear prospects for cost reduction strategy and time value for money should be the basis for selecting public-construction project procurement systems. Procurement for public construction projects is challenging for procuring entities due to the fragmentation of the construction industry, which is "apparent most especially in the traditional separation of design and construction processes" (Jimoh et al, 2016, p.1096). Procuring entities and their procurement units require expertise correlating the government's project objectives with appropriate procurement approaches for attaining value for money and cost control during project implementation. Through making informed decisions at the contractor selection stage, procurement entities and units ensure the completion of public projects within acceptable costs, without delay and abandonment (Ajayi et al, 2010). The main contributor to public project failures is a lack of control and appreciation of procurement selection procedures and regulations by procurement units (CRC, 2009). Procurement strategy for public projects is thus a very critical subject that requires rigorous cost-benefit and price-sensitivity analysis for successful implementation.

Procurement provisions for acquiring public construction works hinder accelerated public service provision (Manyathi, et al., 2021). Procurement legislation is inefficient and ineffective and fails to govern how to procure public infrastructure works adequately (IMF, 2023). To mitigate shortcomings of procurement legislation, governments need to remove unnecessary red tape that discourages innovation while establishing benchmarks for detecting inexperienced and fraudulent contractors. Procurement legislation encourages tendering, a troublesome practice that impedes learning and obtaining total value (Arlbjørn & Freytag, 2012). Public-sector procurement is inherently different from private-sector procurement because that is mainly profit-driven. Public procurement addresses numerous social issues and requires thoughtfulness of its varied nature for specific demand environments. For example, public procurement for works requires entirely different practices, approaches, and skill sets than public procurement for goods and other services. In that regard, generic procurement legislation is unlikely to work in a public infrastructure context (Uyarra & Flanagan, 2009). Procurement legislation is essential to establishing policies for increased innovation regarding procurement models for contracting for public works.

Despite increased research on public procurement (Demircioglu & Vivona, 2021; Yusuf, et al., 2022; Fourie & Malan, 2020; Odhiambo & Theuri, 2015), the relationship between public procurement and managing prices for construction works remains unexplored. The study highlights the significance of procurement strategy in managing construction tender prices in public infrastructure projects. The study aims to contribute to practice and theory by offering lessons on using the procurement function to manage tender price levels and conceptualize the procurement function as a substantive strategy for increased delivery of public infrastructure. The question guiding this paper's analysis is 'why is the IRCP tender price level lower than that for government-sponsored periodic maintenance of feeder roads?' In doing so, the study explores factors affecting procurement strategy adoption. In addition, the study investigates procurement considerations and strategies for efficient tender-price management, focusing on the effects of current procurement selection strategies.

2. Literature Review

The paper analyzes extant scholarly literature on tender price management to provide an overview of factors affecting adoption of a procurement strategy. The section further reviews the effects of extant procurement strategies on the tender price level. The literature serves as the foundation for this paper, guiding its methodology and choice of applicable theories.

2.1 Theoretical review

The study organizes its theoretical framework into two sections. The first section involves the agency cost theory, which attempts to reveal numerous factors that influence construction tender price development from the contractor's perspective. The second section highlights the importance of a resource-based approach to enhancing government roles and

involvement and highlights the institutional perspective regarding developing and adopting a procurement strategy. This study aims to examine and establish any relationships between construction industry actors in addressing construction tender-price inflation. The agency cost is crucial in the study because it allows the research to investigate concepts such as interaction, environment, and behavior, thereby assisting the research in examining the thought processes of public construction agents. The resource-based theory allows the study to determine the government functioning model and reveal the strategies and role of government through public infrastructure delivery aspects.

2.1.1 The agency cost theory

The Agency Theory assumes that (1) both agent and principal are intently self-interested, (2) both agent and principal are rational, and (3) agents always seek to minimize risk (Bosse & Phillips, 2016). The theory explains how the principal (government) engages an agent (contractor) to execute construction works. The theory attempts to reconcile the goals and objectives of the agent to those of the principal. The idea is essential in managing contractors on construction sites as it tries to address principal-agent risk tolerances (Markowitz, 2005). The Agency Theory presents the client with a rational contractor who, instead of "furthering their interests, is aiming to maximize own usefulness" (Glinkowska & Kaczmarek, 2015, p. 88). This theory explains the specific behaviors of construction contractors that collectively create financial problems in public infrastructure delivery. "Essential features of the agency problem are that the interests of the principal and agent diverge, resulting in unmeasurable and significant costs and inefficiencies ultimately borne by society" (Bosse & Phillips, 2016, p. 276).

Today's agency theory assumes the pursuit of self-interests at any cost due to "simplistic and unrealistic premises which constitute the basis of the theory" (Kultys, 2016, p. 632). Kultys (2016) suggests numerous additional requirements for reshaping relationships between the principal and the agent to benefit the public. The theory structure does not sustain nor necessarily protect the public from competing self-interests. Kathleen M. Eisenhardt (1989) concluded that agency theory is an empirically valid perspective that offers an exceptional perception of sector uncertainty and risks only when coupled with complementary perspectives. Governments (clients) must realize that the lack of balancing views in applying the theory makes it narrow and dangerous. Hence, there is a profound need to utilize the theory in examining and realigning the relationship between clients and contractors by focusing on the theory's strengths, weaknesses, opportunities, and threats. Today's challenges in public sector construction projects exposed severe dysfunctions in government-contractor relations that are inspiring to scrutinize the theoretical and practical components of the agency theory applicability. The theory remains an undisputedly popular approach in implementing public infrastructure projects, yet "normatively and theoretically the theory is more problematic than is usually recognized" (Widmalm, 2016, p. 127). Problems in public construction sector have arisen within the 'nexus of contractor's bids' that characterize the modern tender pricing procedures where contractors act to control costs by maximizing firm profits. It is where contractors' interests have likely diverged from the employer's. Accordingly, Sanfelix and Puig (2015) argued that applying Agency Theory is successful in traditional sectors with easily standardized processes and procedures.

2.1.2 Resource-based theory

The competitiveness in the modern construction sector depends on one's ability to utilize the knowledge and sufficiently exploit knowledge flows within the organization (Villasalero, 2016). This theory posits that organizations should look internally to build that competitive advantage through their resources. The resource-based theory states that possessing resources is valuable, inimitable, rare, and challenging to substitute (Chuang & Lin, 2017). Therefore, governments need to develop and utilize their knowledge flows to benefit from their existing inimitable resource base within the public construction sector instead of relying on contracting out all public works. The relational view of the resource-based theory places governments in some global competition to deliver public infrastructure through linkages or networking (Wong, 2011) and or tapping into other firms (contractors) to meet their obligations by mobilizing external resources in construction.

The resource-based theory of competitive advantage, if used as a framework for innovative implementation of public construction projects, should work in favor of the government, for it possesses a great extent of valuable resources. The theory argues that support and sustainability of internally executed public infrastructure are attainable through (1) utilizing internal resources of government, (2) enhancing the government's capabilities in using those resources, and (3) ensuring innovation's contribution to the financial performance of government (Holdford, 2018). Governments are in a good position to implement accessible composite frameworks or models that elaborate the natural relationship between

resource-based and knowledge-based views in developing specific assets and ensuring that society fully benefits from that unique competitive advantage (Theriou, et al., 2009).

The resource-based theory makes valuable contributions, particularly when formulating strategic alliances with contractors based on rationale and performance (Das & Teng, 2000): in line with support to transactional price economics in public construction projects through utilizing internal resources of government. Governments can harness both their tangible and intangible resources, leading to unprecedented competitive advantage and securing societal benefits by regularly interrogating perspectives of their resource-based views. Under the Resource Based Theory, governments can perform better if they internally implant public construction projects because they hold valuable assets and unique characteristics.

2.2 Advantages and disadvantages of extant procurement strategies

The paper investigates several procurement strategies commonly used in the construction sector and public organizations. Table 1 outlines the advantages and disadvantages of each strategy.

2.3 Factors affecting the adoption of a procurement strategy

Ogunsanmi (2013) researched the effects of procurement-related factors on construction project performance in Nigeria and found that cost-related factors showed the highest impact on project performance of all procurement selection criteria. His findings further show that other factors, particularly time and quality, influence public construction project performance. Due to the complex nature of construction projects, there is no single approach to selecting an appropriate procurement strategy for an individual project. For the successful implementation of a project, there is a need to consider a decision-support model that encompasses all the factors that might be significant (Ratnasabapathy & Rameezdeen, 2007). Rajeh et al. (2014, p.56) argue that the selection of an appropriate procurement strategy is an essential element to project success and should consider factors such as "cost, quality, time, project complexity, certainty, risk, responsibility, and degree of control by the client." Love et al. (2008) found an entrenched culture of uncertainty avoidance guiding selection while researching procurement methods in Australia.

Dahiru and Bashir (2015) found the existence of risk-related factors that restricted the success of construction procurement performance by causing a substantial increase in the overall project cost leading to an increase in the tender price. Their results are essential to developing a supportive mechanism for risks management in public construction procurement management by recognizing that "corruption-related risk, conflict of interest, ineffective project technical feasibility, and lack of commitment to transparency are the most significant factors limiting construction procurement performance" (Dahiru & Bashir, 2015, p.77). They recommend selecting a construction-procurement system by focusing on curbing risks related to corruption, conflict of interest, and practical technical feasibility when attempting to improve the whole project's performance. El Agha and El Sawalhi (2013) found six significant factors that influenced the selection of Construction procurement methods in the Gaza Strip. These factors include price competition; degree of project complexity, time constraints, project size; client's financial capability, and experience in procurement methods.

Bakar et al. (2009) carried out research involving five non-governmental organizations following the devastation caused by a 9.2 earthquake in Aceh, Indonesia. Their findings show factors that influenced the procurement method for the reconstruction efforts included timing, responsibility, and the quality of work. In comparison, Ajayi et al. (2016) found, in their research on procurement selection criteria for projects in the public sector in Nigeria, that quality, cost, and duration of the project determined the type of procurement method to implement. In Tanzania, procurement processes are directly affected by a lack of knowledge in ICT when using E-procurement, poor record keeping, and a lack of personnel training on procurement matters (Ivambi, 2016). The principal factors that influence the selection of procurement systems include; the client's willingness to be actively involved; the flexibility to change design during both the design and construction period; risk allocation/avoidance; project size; client's experience; the certainty of cost and time; experienced contractor availability; client's trust in other parties; client's requirement for value for money; and project type (El Sawalhi and El Agha, 2016).

2.4 Effects of multiple sourcing strategies in Zambia

In Zambia, all procuring entities use multiple sourcing strategies coupled with the lowest price selection practices. According to the Zambia Public Procurement Act (2020), a procuring entity means a government agency, parastatal body, or any other body or unit established and mandated by the government to procure public funds.

Table 1: Advantages and disadvantages of procurement strategies

Procurement Strategy	Description	Author(s)	Advantages	Disadvantages
Single/Sole Sourcing	A Procurment strategy in which works are obtained from a single supllier without competitive bidding	Costantino & Pellegrino (2010) Inderst (2008); Mandal (2015) Faes & Matthyssens (2009) Chen (2016) Kimetto et al. (2019) Washington (1997) Cachon & Zhang (2006)	1. Emboldens simplified supply chain management for more vital collaboration 2. Encourages negotiations, thereby increasing the potential for price discounts 3. High potential for long-term mutual benefits	1. Higher vulnerability and risk exposure resulting from dependency 2. Hinders cost reduction due to lack of price competition 3. Higher prices resulting from lack of competition
Multiple Sourcing	A Procurment strategy in which works are acquired from a multiple supllers through competitive bidding	Costantino & Pellegrino (2010) Inderst (2008); Mandal (2015) Faes & Matthyssens (2009) Chen (2016)	Better pricing resulting from increased competition	Loss of negotiation power by the client
Modular sourcing	A Procurement strategy that involves breaking down complex project or service into distict components that are later sourced independently from different suppliers	Buchmüller et al. (2018) Knittig et al. (2004) Becker et al. (2021)	Reduced logistic and material costs	Creates dependencies that lead to the exploitation of the market by contractors or suppliers
Outsourcing	A Procurement strategy in which an organization contracts tasks to a third party service provider rather than doing them inhouse	Somjai (2017) Moh'd et al. (2016) Ana-Maria (2015) Kremic et al. (2006) Lankford & Parsa (1999)	Better economies of scale lead to cost savings	1. Creates dependency on the contractor's reliability 2. Hidden costs
Insourcing	A procurement strategy of perfoming tasks internally within an organization rather than outsorcing from third parties	Foerstl et al. (2016) Constantin & Hila (2014)	High potential for cost savings due to better alignment of organizational goals and objectives	Increased operational and administrative overhead costs
Global Sourcing	A procurement strategy in which an organization acquires services, goods or works from suppliers who are located in diffrenet countries	Kotabe & Murray (2004)	Provides access to a broader range of global markets	Increased costs due to complexities in supply chain management

Multiple sourcing is challenging for procuring entities due to the fragmentation of the construction industry, which is "apparent most especially in the traditional separation of design and construction processes" (Jimoh et al., 2016, p.1096).Procuring entities and their procurement units require expertise correlating the government's project objectives with appropriate procurement approaches for attaining value for money and cost control during project implementation. In terms of the impacts of current strategies, Table 2 lists the effects of multiple sourcing procurement strategies and practices gathered from the literature. The notable impact of multiple sourcing methods and techniques includes increasing project costs, enabling profit repatriation by foreign firms, and complicated bidding decisions due to derisory and limited scope of selection criteria. In addition, current procurement practices encourage imperfect competition, emphasizing a focus on price and transferring uncertainties onto project performance. Failure to highlight the client's and project-specific requirements often leads to selecting incompetent contractors.

Table 2: Effects of multiple sourcing procurement strategies

Impact	Observations based on literature	References
Increase project costs	Embody lowest price selection leading to imperfect competition by artificially lowering prices.	Bochenek (2014), Ajayi, et al. (2010) and Lavelle, et al. (2007)
Profit repatriation	Permit multinational construction companies to dominate the construction industry.	John et al. (2019)
Complicates Bidding Decision	Evaluation of the competitive bidding model in public projects places particular emphasis on price.	Alzober & Yaakub (2014)
Imperfect competition	Focus on price competition among bidders	Thiruchelvam & Tookey (2011)
Uncertainties about project performance	Ignores the procurement impact on project performance	Ogunsanmi (2013), Demirkesen & Bayhan (2019), Rajeh, et al. (2014) and Ghadamsi (2016)
Derisory selection criteria	Fails to consider many technical and commercial factors	Lavelle, et al. (2007), Ajayi, et al. (2010), Rajeh, et al. (2014) and Ajayi (2017)
Selection of incompetent contractor	Fails to emphasize the requirements of the client and project	Dwarika & Tiwari (2014)

Through making informed decisions at the contractor selection stage, procurement entities and units ensure the completion of public projects within acceptable costs, without delay and abandonment (Ajayi et al., 2010). The main contributor to public project failures was a lack of control and appreciation of procurement selection procedures and regulations by procurement units (CRC, 2009). Procurement for public projects is thus a very critical subject that requires rigorous cost-benefit and price-sensitivity analysis for successful implementation. An informed approach to the selection of the most appropriate procurement system is central to the success of any public infrastructure project. Choosing a proper procurement system, crucial in implementing public projects, is even more difficult with the increasing fragmentation and complexity of the construction industry. The failure to decide on an appropriate procurement system could result in time delays, cost overruns, and quality problems (Al-Jawhar and Rezouki, 2012). Silwimba & Mwiya (2017, p.10) rightfully argue that "project success or failure is not dependent on a procurement method alone."

The literature shows that an implementation gap exists such that public infrastructure-based clients often overlook that the suitability of a procurement strategy is dependent on the nature of the project and specific organizational goals and objectives. Therefore, they implement extant procurement strategies without carefully evaluating particular requirements to select and adapt the most appropriate practices that cultivate the best and most practical benefits of a chosen approach.

3. Methodology

The study is an exploratory case study utilizing a desktop review of numerous publications, public domain reports, and person-to-person interviews. The choice of methodology corresponds to the specific nature of the research environment and phenomena characterization of the lack of detailed primary research. The research involves a robust examination

of documents and trend analysis of public procurement. It results from extensive extant literature, nine case study packages of improved rural connectivity projects (IRCP), and 21 expert interviews. Improved rural connectivity project (IRCP) is a World Bank-funded project for improving Zambia's rural road accessibility and strengthening institutional capacity. The project aims to improve selected feeder roads through upgrading, habitation, and maintenance interventions. The project enhances feeder roads to gravel and low-cost-seal standards. The project has several components; however, the study concentrates on the construction component of feeder roads. The study adopts a purposive and snowball sample of experts and personnel involved in the execution or implementation of IRCP. The study identified and interviewed seven respondents directly managing IRCP projects and interviewed 14 key industry experts later. The paper adopts an unobtrusively qualitative approach to generate specific characteristics of improved rural connectivity projects (IRCP), procurement considerations, and strategies for efficient tender-price management.

3.1 Respondents' profile

Respondents included vital industry stakeholders (Table 3) whose age group ranged between 35 and 65 years. The respondents' experience was crucial in determining the evolution and true nature of the construction industry regarding tender price management. Table 3 shows the respondents' classification into six general practice areas. The target for each category is to represent a specific industry and project professional contribution. Of the fourteen (14) respondents, three were civil engineering consultants, three contractors, two architects, three quantity surveyors, two civil engineers (client representatives), and one procurement specialist.

Table 3: Professions sampled

Qualification/Area of Practice	No. of Participants (n=14)	Percentage (%)
Civil engineering consultants	3	22
Contractors	3	22
Architects	2	14
Quantity Surveyors	3	21
Civil engineers/client representative	2	14
Procurement expert	1	7
Total	14	100

Four respondents had over 30 years of experience; seven had experience ranging between 20 and 30 years, while three had practical experience between 15 and 20 years (Table 4). The sample group profile indicated that respondents comprised 22% civil engineering consultants, 22% contractors, 21% quantity surveyors, 14% architects, 14% client representatives, and 7% procurement experts. All respondents were construction-project managers with holistic understanding and experience regarding the construction sector and its various aspects. The selection of respondents reduced the selection bias while improving the representativeness of the sample categories. Among the respondents, one had a Ph.D.; two had bachelor's degrees, and eleven had master's degrees (seeTable 4).

3.2 Methods of Data Analysis

The study presented the findings as verbal accounts and narratives of lived experiences gathered through interviews. The study utilized thematic analysis of key informant interviews to extract price mitigations and envisaged strategy characteristics.

4. Findings

For this study, a focus on reliable documents such as Auditor General's reports, project progress reports, and interviews generated relevant data for analysis regarding procurement strategies for managing construction prices. Table 5 outlines the packages (and their corresponding detail) of the IRCP project. Table 5 indicates that improved rural connectivity projects (World Bank funded - IRCP) had an average construction tender price of ZMW610,069.28/km or ZMW707,680.36VAT Inclusive (for the same period), about 32% lower than that for (similar projects) unpaved roads under government funding shown in a cross-case analysis in Table 6.

Table 4: Participants for research interviews

Description	Age	Academic qualification/Highest level of education	Experience (years of practice)	Area of Practice/Expertise
PP1	47	Bachelor of Engineering (Civil & Environmental Engineering)	22	Civil engineering consultant
PP2	40	MSc Project Management	18	Contractor
PP3	65	MSc (Construction Management & Economics)	40	Quantity surveying & Construction management
PP4	52	Bachelor of Engineering (Civil & Environmental Engineering)	27	Civil Servant/Public Infrastructure-Based Institution
PP5	42	MSc Business Management Bachelor of Engineering (Civil Engineering)	17	Contractor
PP66	39	MEng Construction Management BSc Architecture	15	Architectural consultant
PP7	51	MSc Project Management BSc Building Science	25	Quantity surveying consultant
PP8	63	MSc Architecture PGDip. Project Management and Building Law; BSc Architecture	30	Architectural consultant
PP9	49	MSc Logistics & Supply Chain management; BSc Procurement Management; Dip. Chartered Institute of Purchasing & Supply	22	Civil Servant/Public Infrastructure-Based Institution
SP1	50	Ph.D. (Transportation Economics) MEng Civil (Pavement & Transportation) BEng Civil & Environmental Engineering	24	Public project financing
SP2	56	MEng Civil (Pavement Design) BEng Civil & Environmental Engineering	30	Civil engineering consultant
SP3	49	MEng Construction Management BEng Civil & Environmental Engineering	25	Civil engineering consultant
SP4	49	MEng Project Management BEng Civil & Environmental Engineering	22	Contractor
SP5	60	MSc Construction Management BSc Quantity Surveying	35	Quantity surveying consultant

Key: Purposive Participant (PP); Snowballing Participant (SP)

Further, preliminary literature indicates that construction pricing is influenced quantitatively by macroeconomic indicators such as inflation, exchange rate, interest rate, government debt, foreign direct investments, imports, trade deficits and budget deficits. Other qualitative factors include but are not limited to the construction price level, procurement strategy, project management practices, project-related risks, corruption, political interferences, adopted pricing models, stakeholder management strategies, political policy, and extant legislative framework.

The findings show that IRCP tender prices do not correlate strongly to macroeconomic indicators compared to government-funded unpaved road projects. IRCP tender prices had a strong negative correlation with interest rates (-0.84). In contrast, tender prices for upgrading to bituminous and periodic maintenance of feeder roads positively correlated with interest rates. In addition, IRCP tender prices show only weak positive correlations to forex and inflation. The averages for IRCP were as low as 71% of the average tender prices of feeder road projects (see Table 5 and Table 6).

Table 5: Construction tender prices for improved rural connectivity project IRCP

Location (Province)	Package No. (Districts)	Project detail	Tender-price VAT Exclusive (ZMW/Km)
Central	Package 1 in Mkushi District (254km)	The contract was signed with Sinohydro Zambia Ltd in May 2019 at a sum of K143,245,597.98 VAT Exclusive	584,675.91
	Package 2 in Chibombo & Mumbwa Districts (247.9km)	The contract was signed with China CAMC Engineering Co. Limited in May 2019 at a sum of K158,222,480.56 VAT Exclusive	640,576.84
Eastern	Package 3 in Petauke & Nyimba District (324.84km)	The contract was signed with China Geo-Engineering Corporation on 8 May 2020 at a sum of K178,467,322.32 VAT Exclusive	549,400.70
	Package 4 in Petauke, Sinda, and Katete Districts (180.95km)	The contract was signed with Zhongmei Engineering Group Limited on 5 May 2022 at a sum of K120,843,552.47 VAT Exclusive;	667,828.42
Northern	Package 7 in Mungwi, Mbala, and Senga Districts (204.36km)	The contract was signed with Sinohydro Corporation Limited on 7 May 2020 at a sum of K101,226,481.85 VAT Exclusive;	495,334.13
	Package 8 in Luwingu and Kasama Distrcts (198.85km)	The contract was signed with China Jiangxi International Economic and Technical Corporation Company Limited on 3 June 2020 at a sum of K91,666,713.42 VAT Exclusive;	460,984.23
	Package 10 in Samfya and Chifunabuli Districts (186.93km)	The contract was signed with Longjian Road and Bridge Company on 11 May 2020 at a sum of K81,585,918.62 VAT Exclusive;	436,451.71
Southern	Package 12 in Zimba, Kazungula, and Kalomo Districts (155km)	The contract was signed with M and N Industrial Merchants Limited on 28 January 2022 at a sum of K115,494,706.94 VAT Exclusive;	745,127.14
Muchinga	Package 14 in Chinsali and Shiwang'andu Districts (186.753km)	The contract was signed with M and N Industrial Merchants Limited on 28 January 2022 at a sum of K143,824,214.14 VAT Exclusive;	770,130.68

External debt averaged 15.05bn, US$16.45bn, and US$17.7bn in 2019, 2020, and 2021 respectively (Tembo, et al., 2023). Macroeconomic values reasonably corresponded to increased construction tender prices for similar government-funded road works. For example, in the period under review, similar government-funded projects indicated a strong positive correlation with foreign exchange rates, while IRCP tender prices only had a weak positive correlation.

Table 6: Cross-case analysis

Case Firms	Main project types	Scope	Intervention	Average construction tender price (ZMW/Km) (VAT Inclusive)
MLGRD	Unpaved - Feeder Roads	Infrastructure design and construction	Periodic maintenance of feeder roads	1,000,912.87 (Tembo, et al., 2023)
MIHUD/ RDA	IRCP – World Bank Funded	Improve rural road accessibility	Output and performance-based capacity building	707,680.36

The IRCP tender prices do not correlate strongly to macroeconomic indicators (Table 7) compared to similar road projects. IRCP tender prices have a strong negative correlation to interest rates. In contrast, tender prices for periodic maintenance of feeder roads positively correlated with interest rates, despite the period between 2019 and 2021 recording average forex rates of 12.91, 18.28, and 20.05, respectively.

Table 7: IRCP tender-prices/macroeconomic correlation coefficients

Year	**2019**	**2020**	**2021**			
	584,675.91 640,576.84	549,400.70 495,334.13 460,984.23 436,451.71	667,828.4 745,127.1 770,130.7	**Averages**	**Coefficient (r) Pearson's**	**Comment**
Average (ZMK/Km)	612,626.38	485,542.69	727,695.41	610,069.28	**-**	-
Forex rates	12.91	18.28	20.05	17.08	**0.21**	Weakly positive
Inflation rates	9.1	15.7	22.1	15.63	**0.47**	Weakly positive
Interest rates	25.6	26.8	25.7	26.03	**-0.84**	Strongly negative
FDI (US $'Bn)	0.55	-0.17	0.19	0.19	**0.52**	Moderately positive

Table 7 indicates a weak positive correlation with forex rates, inflation rates, and FDI. However, there is a strong negative correlation between IRCP tender prices and interest rates; there is enough evidence of other factors' significant influence on construction tender prices. This section explicitly studies the rationale and factors that affect IRCP tender pricing to develop critical mechanisms toward coherent conceptualization of factors influencing tender pricing. The study derived IRCP-specific characteristics from the content and thematic analysis of the interview data set. The final list of drivers to IRCP tender pricing includes seven emergent themes (see Table 8).

Table 8: IRCP Characteristics

Emergent theme	**Comments from interviewees**
Cash flow assurance	Funds are readily available; There is assured cash flow.
Guaranteed payments	Payments are made on time; there is payment certainty; payments are guaranteed.
Completeness of designs	Designs are completed before procurement processes commence.
Competitiveness	There is high competition, competitive prices due to increased demand, and fewer jobs; international competition improves pricing modeling.
Breakeven strategy	Foreign firms want to stay in construction as long as they can; the industry has slowed down, so the IRCP offers the only viable projects on the market, and contractors are strategizing to bid as low as possible so that they can at least have some works to guarantee some income.
Work Packages (Procurement strategy)	Breaking work into packages creates demand, giving potency for competitive pricing, a stringent procurement process that requires an understanding of bid rates.
Government support	Foreign firms win all IRCP projects because they receive (their) government support such that they can outbid local contractors with artificially low prices.
Protecting market share (Life cycle strategy)	Foreign firms have created a competitive advantage in the construction market, and they know that government projects have gone down; so instead of leaving for other global markets due to reduced government spending on projects, they stay longer by lowering prices just to be able to sustain their operations without having to pack up.

In that regard, the study identifies eight procurement-related driving factors that influence the development of tender prices for IRCP projects, which include cash flow assurance, guaranteed payments once contractors make a claim, completeness of designs during tendering that allow bidders to make more precise estimations and high levels and standards of competition. Other factors include attempts by foreign firms to breakeven to prevent exiting the industry as government-related works slow down, and the procurement strategy of packaging work into small lots, thereby simultaneously generating and guaranteeing demand.

Regarding optimal procurement implementation and strategy, research findings reveal ten procurement aspects for developing a procurement strategy presented in Table 9. The study derives and clusters the features through analysis of interview contents. The clustering indicates the following elements for procurement consideration: ensuring adequate project budgeting, timely procurement planning, enhancing usage of the construction price index, ensuring early involvement of contractors, legislating preferential procurement for local contractors, and rationalizing competition and procurement process. Others include providing adequate information and communication management and differentiating construction procurement laws from general procurement laws. Further, Table 6 categorizes strategies for managing construction tender prices through procurement function into three main approaches: Procurement planning, Protectionism, and Procurement policy.
The study findings indicate that procurement strategies such as procurement planning, protectionism, and policy provide adequate room for the broad spread of tender-price management challenges. Table 9 identifies procurement strategies of significance for efficient price management and performance in the construction sector, and methodologies to achieving them include: developing informed engineers' estimates early during project planning stages, benchmark prices of construction elements through price indices and developing procurement controls for tendering processes, which enhance market predictability, improve stakeholder involvement and understanding of project requirements, building capacity and resilience of local firms to ensure competitiveness by developing exclusion and inclusion criteria, anticipating instability of macroeconomic indicators, eliminating tender errors, and streamlining and shortening procurement processes. Others include ensuring transparency and developing appropriate information dissemination criteria, localizing the context of international bidding standards and promoting partnerships by making local firms lead participants, ensuring clarity of tender documents from the onset and eliminating human error or influence in handling documents, and ensuring construction professionals manage construction project procurement by developing construction-specific procurement laws and involving construction professionals in procurement policy-making

5. Discussion

Findings from the study suggest that significant adverse effects of extant procurement strategies eminent from failure to develop their strategy coupled with a copy-and-paste approach to implementing procurement processes. Following this argument, indications of procurement problems such as failure to domesticate procurement strategies suggest a lack of information, innovation, and primary usage of available strategies. Odhiambo & Theuri (2015) highlighted a high correlation between organizational performance and human resource skill level regarding the effective implementation of public procurement processes. Odhiambo & Theuri (2015) also suggest a positive correlation between contractor management and organizational performance. This study finds that the early involvement of contractors is a sure way of improving stakeholder involvement during procurement planning. It is reasonable to allege that a lack of clearly defined project technicalities and poor stakeholder understanding of project requirements prove an inert lack of stakeholder integration. The study finds that contractors account for lack of project understanding through increasing tender prices. Other studies show that stakeholder integration should be encouraged throughout procurement (Mensah & Tuo, 2013; Rebs, et al., 2018; Bohari, et al., 2020).

Table 5 findings indicate the significance of the completeness of project designs and procurement documents before commencing a procurement process during the development of tender prices. Findings by Subramani et al. (2014) and Gomarn & Pongpeng (2018) further argue that deficiencies in project procurement management and documentation cause delays in project implementation and cost escalations. This study further finds that contractors tend to price with a consideration of such deficiencies to avert obvious related multiple underlying risks.

Table 9: Procurement considerations and strategies for efficient tender price management

Procurement considerations	Relevance	Interviewee comments	Procurement Strategy
Ring-fence adequate project budget **Ensure timely procurement planning**	Develop informed engineers' estimates early during project planning stages	• Utilize experienced professionals (quantity surveying consultants) • Include estimated budgets of the project in the tender	Planning
Enhance the construction price index	Benchmark prices of construction elements	• develop procurement controls for tendering processes • enhance market predictability	Planning
Early involvement of contractors	Improve stakeholder involvement	• clearly define project technicalities • enhance stakeholder understanding of project requirements	Planning
Legislate preferential procurement for local contractors	• Build capacity and resilience of local firms • Ensure fair competition	• Utilize joint ventures • Develop exclusion and inclusion criteria	Protectionism
Rationalize competition and procurement processes	• Build capacity for local firms • Anticipate instability of macroeconomic indicators	• Eliminate tender errors • Streamline and shorten procurement processes • Shorten procurement process • Streamline competition	Protectionism
Information and communication management	• Ensure transparency and appropriate information dissemination criteria	• Utilize corporate governance principles • Depoliticize the project procurement process	Policy
Contextualize international bidding standards	• Localize the context of international bidding standards	• Make local firms more competitive • Promote partnerships by making local firms lead participants	Differential Procurement Policy
Model procurement documents	• Ensure clarity of tender documents from the onset	• Develop clear bidding procedures • Ensure fairness during procurement • Eliminate human error or elements in handling documents	Policy
Differentiate construction procurement laws from general procurement laws	• Adjust some of the provisions in international contracting and procurement forms to suit the local market • Ensure construction professionals manage construction project procurement	• Develop construction-specific procurement laws • Involve professionals in policy-making	Differential Procurement Policy

Interviews (Table 5) show that contractors lowered their tender price in an event where all procurement and project-related documentation is considered 'complete.' Extant research (Hamzah, et al., 2011; Gebrehiwet & Luo, 2017) focuses on the direct relationship explained by inadequate design and project documentation on project reworks, variations, and delays. The study finds (Table 6) that eliminating tender errors, developing clear bidding procedures, and eliminating human error or elements in handling documents are crucial in modeling procurement documents that ensure price clarity.

The study finds the need to build the capacity and resilience of local firms and ensure fair competition. Table 6 identifies two specific ways of utilizing joint ventures and developing exclusion and inclusion criteria for foreign firms to capacitate local contractors. The procurement function needs to legislate preferential procurement for local contractors by establishing a preferential procurement policy framework that specifies categories of preference in the allocation of contracts regarding the nationality-ownership of firms. It ensures the protection of local firms against unfair competition as well. However, protectionist policies must be accompanied by more dynamic public supply chain management systems that provide consequences for local firms that, despite support, fail to perform as required (Nkwe, et al., 2015). Smallwood et al. (2011) agree that preferential procurement requires streamlining capacity-building programs and developing procurement performance management systems to work. Table 5 indicates the significance of government support regarding winning a construction tender. The case study shows that foreign firms win improved rural connectivity project packages because they receive government support to outbid local contractors with artificially low prices. Hlakudi (2015) and Magoro and Brynard (2010) warn of the challenges of implementing preferential procurement policies, including late supplier payment government incompetence, increased non-compliance with procurement processes, and corruption and fraudulent activities.

Further, the study finds that IRCP case study packages obtain low construction tender prices attributable to cash flow assurance. The study observes that a 'World Bank' procurement culture of ring-fencing project funds for timely payment of construction work receives critical consideration during the development of tender-price by bidders. A study by Hlakudi (2015) makes a similar observation in its recommendation to 'ring-fencing the budget' for public project execution and prevent payment delays by the government. On the other hand, Bevan (2007) argues against ring-fencing government expenditure as national budgets should naturally combine spending varieties for optimizing government objectives without offering sectorial-special guarantees, which may compromise particular abilities and functions of government. And yet, this study finds that ring-fencing project funds provide a much-needed guarantee that contractor payments would not be delayed. This guarantee results from appropriate procurement planning that enables contractors to price lower, as in the case of IRCP packages. The study considers the ring-fencing of project funds critical management essential to construction project success. The study reveals how the ring-fencing factor is tightly related to project cost control by the client and the bid-price decision of the contractor. Ramlee et al. (2016) agree that project cost is a critical success factor for guiding and predicting future project success. The study finds that ring-fencing enhances the relationship between bid-price management in the construction industry and project management performance.

6. Conclusion

Construction procurement delivers value for all project dimensions, including tender price and long-term cost reduction. Consequently, construction procurement devises strategies for mitigating tender-price inflation appropriately and sufficiently. Construction procurement develops and implements appropriate price management systems to deliver value and reduce and control construction tender prices. The study explored procurement strategies in the context of managing construction tender-price. Eight fundamental characteristics related to a successful procurement strategy identified are cash flow assurance, guaranteed payments, and completeness of designs. Other characteristics include level and type of competition, contractor's breakeven point, adopted procurement process (work packaging), nature of government support, and protecting market share. The study further identifies central areas for developing a successful and responsive procurement strategy: procurement planning, preferential procurement policy (protectionism), and establishing differential procurement laws. These findings form an appropriate basis for developing a relevant procurement strategy for managing construction bid prices.

Findings suggest an appreciable occurrence of current procurement strategy constraints linked to evidence of project cost increase, profit repatriation, imperfect competition, project performance uncertainties, and derisory selection criteria. There is an indication of optimal adoption of the lowest price selection strategy in public procurement to manage construction tender-price. This approach creates imperfect competition by artificially

lowering prices at tendering and later subjecting the project to other cost-related risks. The study findings indicate the possibility of further exploiting the potential of current procurement strategies for managing construction prices. The study suggests a link between poor tender-price management and a high occurrence of procurement-related lapses. The findings highlight gaps only identifiable in tender-price management studies when taking a client perspective and considering the procurement context. The paper provides a management perspective for exploring and investigating the use of procurement strategies to address a tender-price management problem instead of popular approaches and studies focusing solely on project cost escalations related to the project implementation phase.

The findings offer insight into managing construction prices through adopting and developing appropriate industry-specific procurement-related interventions. The study also contributes knowledge concerning price-driven performance in construction. Extant studies referenced and discussed in the paper explore the effects of adopted procurement strategies and construction project-related constraints. This study has examined a gap regarding construction tender-price level with a specific focus on utilizing procurement functions to manage construction tender-price in developing countries like Zambia. The paper provides an explicit basis for future studies into building a more robust understanding regarding the contribution of the procurement function to construction price levels in other developing countries.

6.1 Limitations

In making the above contribution, the study is limited to only nine 'World Bank-funded rural connectivity project packages.' It may, as a result, affect the generalizability of the results. However, the research sets a baseline for studying the procurement function concerning tender-price management. Considering this limitation, future studies need to increase the number of cases for more extensive practical evidence.

6.2 Theoretical Contribution

The findings indicate that agent behavior is determined and influenced by the nature and type of the principal, which means that the agent's rationality is directly proportional to the rationality of the principal. While numerous other research recognizes that the principal and agent act rationally, this research indicates rationality's nature. The study's findings contribute to the agency theory in expounding and understanding how agents seek and deploy ways to minimize risk and maximize profit at the expense of principal behavior. The study provides empirical evidence to Widmalm's (2016) research, which points to problems of the theory. This research empirically establishes that modern tender pricing procedures where contractors act to maximize profit by anticipating employer behavior is the central area where agents' interests have significantly diverged from those of the employer in public construction sector. Accordingly, this study theorizes that, in practice, the agency theory, in its traditional form, does not apply to modern public construction sector practice in developing countries like Zambia.

Regarding resource-based theory as theorized by other research (Villasalero, 2016; Wong, 2011; Holdford, 2018; Theriou, et al., 2009), the study finds that governments in developing countries like Zambia have failed to utilize their unique competitive advantage to create and implement composite frameworks encompassing their resource-based and knowledge-based views. Hence, in practice, this study contributes to the work of Das & Teng (2000) to enhance strategic alliance with contractors based on rationale and performance for resource-based theory to make a valuable contribution. Under this theory, this study posits that governments can better harness resources if they implement some construction projects internally.

6.3 Practical Implications

The study offers several practical implications that significantly impacts the overall performance of the public construction sector:

1. Cost estimation: understanding tender prices allow public institutions to accurately estimated the cost associated with a project. This enables them to prepare competitive budgets that reflect the true cost of delivering construction projects.
2. Bidding strategy: understanding tender prices helps public institutions assess market trends. This information assists to develop procurement strategies that enhance the chance of deriving value for money while maintain reasonable price levels.
3. Risk Management: studying tender prices provides insights into potential risks associated with construction projects such as budget overruns and project disruptions. This also helps public institutions allocate resources effectively at planning stage.

Contract negotiation: knowledge regarding tender prices serve as a basis for contract negotiations between contractors and clients. By understanding the factors that influence tender prices, public institutions can develop policies and negotiate contract terms that are protect their Interests.

References

Ajayi, J. R., Oyekunle, O. L., & Olanrewaju, A. N. (2016). Procurement selection criteria for projects in the public sector: Evidence from Nigeria. *Independent Journal of Management and Production (IJM&P)*, 7(4).

Ajayi, O. M. (2017). Relative importance of contractor selection criteria for construction projects in Nigeria. *Ethiopian Journal of Environmental Studies & Management*, 10(8), 992–1001.

Ajayi, O. M., Ayanleye, A., & Achi, F. (2010). Criteria for selection of subcontractors and suppliers in a building project in Lagos State, Nigeria. In *Proceedings of the 5th Built Environment Conference* (pp. 56–65). Durban, South Africa: Association of Schools of Architecture of South Africa (ASOCSA).

Ajayi, O. M., Ayanleye, A., Achi, F., & Johnson, O. (2010). Criteria for selection of subcontractors and suppliers in a building project in Lagos State, Nigeria. Lagos: Association of Schools of Architecture of South Africa (ASOCSA).

Alzober, W., & Yaakub, A. R. (2014). Integrated model for selection the prequalification criteria of contractor. *Lecture Notes on Software Engineering*, 2(3), 233–237.

Ana-Maria. (2015). The risks and benefits of outsourcing. *Knowledge Horizons - Economics*, 7(2), 103–104.

Arlbjørn, J. S., & Freytag, P. V. (2012). Public procurement vs private purchasing: Is there any foundation for comparing and learning across the sectors? *International Journal of Public Sector Management*, 25(3), 203–220.

Becker, T., Bruns, B., Lier, S., & Werners, B. (2021). Decentralized modular production to increase supply chain efficiency in chemical markets. *Journal of Business Economics*, 91(6), 867–895.

Bevan, D. (2007). Promoting and protecting high-priority expenditures. Washington, DC: Center for Global Development.

Bochenek, J. (2014). The contractor selection criteria in open and restricted procedures in public sector in selected EU countries. *Procedia Engineering*, 85, 69–74.

Bohari, A. A. M., Bo, X., & Khalil, N. (2020). Key stakeholder values in encouraging green orientation of construction procurement. *Journal of Cleaner Production*, 270.

Bosse, D. A., & Phillips, R. A. (2016). Agency theory and bounded self-interest. *Academy of Management Review*, 41(2), 276–297.

Buchmüller, M., Eidmüller, T., & Mussmann, A. (2018). The status of modular sourcing compared to other procurement strategies. *Ecoforum Journal*, 7(1), 1-9.

Cachon, G. P., & Zhang, F. (2006). Procuring fast delivery: Sole sourcing with information asymmetry. *Management Science*, 52(6), 881–896.

Chen, J. (2016). Sourcing for quality: Cooperating with a single supplier or developing two competing suppliers? *Mathematical Problems in Engineering*, 1–13.

Chuang, S. H., & Lin, H. N. (2017). Performance implications of information-value offering in e-service systems: Examining the resource-based perspective and innovation strategy. *The Journal of Strategic Information Systems*, 26(1), 22–38.

Constantin, M., & Hila, O. D. (2014). Outsourcing within a supply chain management framework. Bucharest, Romania: s.n.

Costantino, N., & Pellegrino, R. (2010). Choosing between single and multiple sourcing based on supplier default risk: A real options approach. *Journal of Purchasing and Supply Management*, 16(1), 27–40.

CRC. (2009). Capital works procurement: The selection of a building procurement method. Brisbane: CRC for Construction Innovation.

Dahiru, A., & Bashir, A. M. (2015). Risk factors influencing construction procurement performance in Nigeria. *Arid Zone Journal of Engineering, Technology and Environment*, 11, 77–88.

Das, T. K., & Teng, B. (2000). A resource-based theory of strategic alliances. *Journal of Management*, 26(1), 31–61.

Demircioglu, M. A., & Vivona, R. (2021). Positioning public procurement as a procedural tool for innovation: An empirical study. *Policy and Society*, 40(3), 379–396.

Demirkesen, S., & Bayhan, H. G. (2019). Subcontractor selection with Choosing-By-Advantages (CBA) method. *IOP Publishing*, s.l.

Dwarika, P., & Tiwari, S. (2014). Evaluating the criteria for contractors' selection and bid evaluation. *International Journal of Engineering Science Invention*, 3(7), 44–48.

Eisenhardt, K. M. (1989). Agency theory: An assessment and review. *Academy of Management Review*, 14(1), 57–71.

El Agha, O. I. (2013). Factors affecting the selection of procurement methods in the construction projects in Gaza Strip. Gaza: The Islamic University of Gaza.

El Sawalhi, N. I., & El Agha, O. I. (2016). Multi-attribute utility model for selection of appropriate procurement method in the construction projects. *Journal of Construction in Developing Countries*, 22(1), 1–26.

Faes, W., & Matthyssens, P. (2009). Insights into the process of changing sourcing strategies. *Journal of Business & Industrial Marketing*, 24(3/4), 245–255.

Foerstl, K., Kirchoff, J. F., & Bals, L. (2016). Reshoring and insourcing: Drivers and future research directions. *International Journal of Physical Distribution and Logistics Management*, 46(5), 492–515.

Fourie, D., & Malan, C. (2020). Public procurement in the South African economy: Addressing the systemic issues. *Sustainability*, 12, 1–23.

Gebrehiwet, T., & Luo, H. (2017). Analysis of delay impact on construction project based on RII and correlation coefficient: Empirical study. *Procedia Engineering*, 196, 366–374.

Glinkowska, B., & Kaczmarek, B. (2015). Classical and modern concepts of corporate governance (Stewardship theory and agency theory). *Management*, 19(2), 82–92.

Gomarn, P., & Pongpeng, J. (2018). Causes of construction delay from contractors and suppliers in Thailand's oil and gas platform projects. *EDP Sciences*, s.l.

Hamzah, N., Khoiry, M. A., Arshad, I., Tawil, N. M., & Ani, A. C. (2011). Cause of construction delay - Theoretical framework. *Procedia Engineering*, 20, 490–495.

Hlakudi, J. N. (2015). The implementation of preferential procurement policy in Gauteng Province: Challenges and solutions. *Africa's Public Service Delivery & Performance Review*, 3(1), 55–73.

Holdford, D. A. (2018). Resource-based theory of competitive advantage – a framework for pharmacy practice innovation research. *Pharmacy Practice*, 16(3).

IMF. (2023). Public procurement in South Africa: Issues and reform options. *Cover IMF Staff Country Reports*, 06 June, 17–30.

Inderst, R. (2008). Single sourcing versus multiple sourcing. *RAND Journal of Economics*, 39(1), 199–213.

Ivambi, S. S. (2016). Challenges affecting procurement processes in public organisations in Tanzania: The case study of Parastatal Pensions Fund-Head Quarters-Dar Es Salaam. Dar Es Salaam: Open University of Tanzania.

Jimoh, A. R., Oyewobi, O. L., & Aliu, N. O. (2016). Procurement selection criteria for projects in the public sector: Evidence from Nigeria. *Independent Journal of Management & Production*, 7(4), 1096–1114.

John, T. A., Alumbugu, P., & Micheal, A. I. (2019). Contract awards disparity among multinational and indigenous construction companies. *Journal of Engineering, Project, and Production Management*, 9(2), 126–131.

Kelman, S. (n.d.). Remaking federal procurement: Visions of governance in the 21st century. Massachusetts: The John F. Kennedy School of Government.

Kimetto, R., Ojino, D. J., & Ayoo, P. N. (2019). Effects of strategic sourcing on organizational performance: A case of Acacia Premier Hotel, Kisumu. *Scientific Research Journal (SCIRJ)*, 7(8), 1–29.

Knittig, P. R., Shimizu, S., & Ballon, R. J. (2004). Modularisation and its limitations in the automobile industry. *Proceedings of the IEEE International Conference on Service Operations and Logistics, and Informatics* (pp. 682–687). Cancun, Mexico.

Kotabe, M., & Murray, J. Y. (2004). Global sourcing strategy and sustainable competitive advantage. *Industrial Marketing Management*, 33(1), 7–14.

Kremic, T., Tukel, O. I., & Rom, O. W. (2006). Outsourcing decision support: A survey of benefits, risks, and decision factors. *Supply Chain Management: An International Journal*, 6(11), 467–482.

Kultys, J. (2016). Controversies about agency theory as theoretical basis for corporate governance. *Oeconomia Copernicana*, 7(4), 613–634.

Lahdenperä, P. (2014). Rationalising public procurement of complex construction projects by the price component selection. In *Proceedings of the 13th International Conference on Design and Decision Support Systems in Architecture and Urban Planning* (pp. 439–453). Dublin, Ireland: Technical University of Delft.

Lankford, W. M., & Parsa, F. (1999). Outsourcing: A primer. *Management Decision*, 34(4), 310–316.

Lavelle, D., Hendry, J., & Steel, G. (2007). The selection of subcontractors: Is price the major factor? In D. Boyd (Ed.), *Proceedings of the 23rd Annual ARCOM Conference* (pp. 65–73). Belfast, UK: Association of Researchers in Construction Management.

Love, P., Davis, P. R., Ellis, J., & Mandal, P. (2008). Procurement selection in the public sector: A tale of two states. In *Proceedings of the 24th Annual ARCOM Conference* (pp. 1215–1224). Cardiff, UK: Association of Researchers in Construction Management.

Magoro, M. J., & Brynard, P. A. (2010). Difficulties associated with the implementation of the preferential procurement policy in conjunction with a low-cost housing programme: A South African contextualisation. *Tydskrif vir Geesteswetenskappe*, 29(3), 215–234.

Mandal, S. (2015). Single or multiple sourcing: A mathematical approach to decision. *International*

Journal of Business and Management Invention, 4(2), 41–51.

Manyathi, S., Burger, A., & Moritmer, N. (2021). Public sector procurement: A private sector procurement perspective for improved service delivery. *Africa's Public Service Delivery and Performance Review*, 9(1), 1–11.

Markowitz, H. (2005). Market efficiency: A theoretical distinction and so what? *Financial Analysts Journal*, 61(5), 17–30.

Mensah, C., & Tuo, G. (2013). Evaluation of procurement processes and its operational performance in the public sector of Ghana: A case study of Komfo Anokye Teaching Hospital and Kumasi Polytechnic. *European Journal of Business and Management*, 5(9), 121–131.

Moh'd, Z., Smadi, A., & Al-Jawazneh, B. E. (2016). The benefits of the outsourcing strategy as perceived by the industrial companies in Jordan. *Global Journal of Management and Business Research*, 16(9), 1–9.

Nkwe, L., Singh, S., & Karodia, A. M. (2015). An analysis of the preferential procurement regulations: A case study of the Department of Communications, Pretoria (South Africa). *Arabian Journal of Business and Management Review (OMAN Chapter)*, 5(4), 90–131.

Odhiambo, A. C., & Theuri, F. S. (2015). Effects of public procurement processes on organization performance. *International Journal of Scientific and Research Publications*, 5(9), 1–6.

Ogunsanmi, O. E. (2013). Effects of procurement-related factors on construction project performance in Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 6, 215–222.

PPA. (2020). National Assembly of Zambia. Retrieved October 3, 2022, from https://www.parliament.gov.zm/node/8634

Rajeh, M., Tookey, J., & Rotimi, J. (2014). Best procurement selection: Development of a conceptual model based on transaction costs. *Australasian Journal of Construction Economics and Building Conference Series*, 2(2), 56–63.

Ramlee, N., Syarif, H., & Shafie, S. (2016). Critical success factors for construction project. *AIP Conference Proceedings*, 1–6. Zurich, Switzerland.

Ratnasabapathy, S., & Rameezdeen, R. (2007). A decision support system for the selection of best procurement system in construction. *Built-Environment-Sri Lanka*, 7(2).

Rebs, T., Brandenburg, M., Seuring, S., & Stohler, M. (2018). Stakeholder influences and risks in sustainable supply chain management: A comparison of qualitative and quantitative studies. *Business Research*, 11, 197–237.

Sanfelix, G. N., & Puig, F. (2015). New challenges in franchisor-franchisee relationship: An analysis from agency theory perspective. *Cuadernos de Gestión*, 18(1), 85–102.

Silwimba, S., & Mwiya, B. (2017). An investigation of the effects of procurement methods on project delivery in the Zambian road sector. *Global Journals Inc.*, 17(3), 10-15.

Smallwood, J., Ncunyana, N., & Emuze, F. (2011). Preferential procurement in the public sector: The case of Amathole. *Acta Structilia*, 18(2), 64–79.

Somjai, S. (2017). Advantages and disadvantages of outsourcing. *The Business and Management Review*, 9(1), 157–160.

Subramani, T., Sruthi, P. S., & Kavitha, M. (2014). Causes of cost overrun in construction. *International Organization of Scientific Research*, 4(6), 1–7.

Tembo, M., Mwanaumo, E. M., & Kahanji, C. (2023). Impact of globalization on sustainable implementation in the construction industry: Dynamics of construction tender-price volatility. *International Journal of Developing and Emerging Economies*, 11(1), 19–53.

Theriou, N. G., Aggelidis, V., & Theriou, G. N. (2009). A theoretical framework contrasting the resource-based perspective and the knowledge-based view. *European Research Studies*, 12(3).

Thiruchelvam, S., & Tookey, J. (2011). Evolving trends of supplier selection criteria and methods. *International Journal of Automotive and Mechanical Engineering*, 4, 437–454.

Turina, N., Radukojkovic, M., & Car-Pusic, D. (2008). *Design and Build in comparison with the traditional procurement method and the possibility of its application in the Croatian construction industry*. Retrieved October 21, 2019, from https://bib.irb.hr/datoteka/362416.65-Turina_Radujkovic_Car-Pusic.pdf

Uyarra, E., & Flanagan, K. (2009). Understanding the innovation impacts of public procurement. Manchester: University of Manchester.

Villasalero, M. (2016). A resource-based analysis of realized knowledge relatedness in diversified firms. *Journal of Business Research*, 71, 114–124.

Washington, W. N. (1997). A review of the literature: Competition versus sole-source procurements. *Acquisition Review Quarterly*, 4(2), 173–188.

Widmalm, S. (2016). After NPM, curb your enthusiasm for the principal-agent theory. Uppsala, Sweden: *Statsvetenskaplig Tidskrift*, 3, 127–143.

Wong, J. (2011). A relational view of resources-based theory: The case of internationalization of Li & Fung Group. *The Journal of Human Resource and Adult Learning*, 7(2).

Yusuf, A., Opawole, A., & Ebunoluwa, E. (2022). Evaluation of the organisational capability of the public sector for the implementation of building information modelling on construction projects. *Acta Structilia*, 29(1), 26–51.

JCBM (2023) 7(3) 34-45

University of Cape Town

Journal of Construction Business and Management

http://journals.uct.ac.za/index.php/jcbm

Re-imagining the Factors Influencing the Choice of Project Management Tools and Techniques in Tanzanian Infrastructure Projects: Elicitation of Practitioners' Perspectives

[1]Nyamagere Gladys Sospeter, [2]Anthony Chang'ah and [3]Pantaleo Rwelamila

[1&2]School of Architecture, Construction Economics and Management, Ardhi University, Dar es Salaam, Tanzania.
[3]Graduate School of Business Leadership, University of South Africa, South Africa.

Received 16 May 2023; received in revised form 28 March 2024 and 02 June 2024; accepted 24 June 2024
https://doi.org/10.15641/jcbm.7.1.1365

Abstract

Construction project Management tools and techniques (CPMTT) are vital for the success of construction projects. Nonetheless, there is a paucity of studies that examined the factors influencing the choice of CPMTT in developing countries, particularly, Tanzania. The objective of the study was to analyze the factors influencing the choice of CPMTT in Tanzanian public infrastructure projects, with the aim to fill the knowledge gap. The study was descriptive in nature and employed a mixed method approach. Using purposive and snowball sampling techniques, data was collected from 60 out of 70 Project management practitioners including Consultants and project Coordinators within Dar-es-salaam Metropolitan Development Projects (DMDP) and similar infrastructure projects. Fifty valid responses were received equivalent to 83% response rate and interviews were done. Quantitative data from respondents was analyzed using IBM SPSS v25. Directed content analysis method was employed for qualitative data from 10 Resident Engineers to supplement the quantitative results. Using factor analysis, four groups of organization support, ease of access and usefulness of tools, fulfillment of project objectives, and project environment and idea generation were determined to influence the choice of CPMTT. Project managers frequently chose tools which could be easily accessible without considering organization project objectives as well as resource commitment. The findings could be used as a guide for project practitioners to critically assess the areas of weakness and select CPMTT that help to address those weaknesses hence improve project delivery in Tanzania, un-explored context. Project managers are called to re-imagine project needs based on priority and select the CPMTT that satisfy the needs based on experience, skills and project objectives as crucial factors in selection of CPMTT rather than using their discretion. This would improve delivery of infrastructure projects hence performance outcomes in the construction sector in Tanzania and other emerging countries. This study was limited to DMDP public infrastructure projects in Tanzania.

Keywords: Construction Project Management Tools and Techniques (CPMTT), Decision analysis, mixed-methods, Tanzania

1. Introduction

Globally, the selection of construction project management tools and techniques (CPMTT) to achieve desired quality and time of the key project stakeholders is becoming increasingly crucial as projects are becoming progressively larger and more complex (Sospeter et al., 2022; Mtanga & Rwelamila, 2019). According to a Chinese Proverb, "to do good work, one must first have good tools." It is also true for project managers, who if they want to deliver good project results, must first have good CPMTT (Milosevic, 2004). Researchers globally acknowledge the relationship of CPMTT with project success (Thawatchai et al., 2019; Doskocil, 2015). Despite the contribution and advancements in CPMTT, project success in the workplace has not improved significantly. Due to projects uniqueness and differences in contexts, CPM frameworks are not generic, they are specifically designed to introduce project management methodologies and tools that ensure the completion of a specific project. The selection and use of CPMTT in achieving the desired project objectives is dependent on crucial factors such as which specific tool is to be used, when is to be chosen and how they are selected. Research studies mention the main risks in executing projects in developing countries as; lack of construction CPM skills and improper selection and use of project tools and techniques (Ogbonna et al., 2018; Al Rawi et al., 2021).

[1] Corresponding Author
Email address: nyamagere@yahoo.com

Inappropriate selection and use of CPMTT has been attributed to cause numerous challenges in projects from disruption of project schedules thus impacting the project performance and delivery (Kikwasi and Escalante, 2020; Chemuturi, 2013; Nguyen, 2020). This is evident as infrastructure development projects have been plagued by project stalling, cost overruns and premature deterioration prior to end-of-life cycle, worse abandoned and unfinished requiring huge amount of money and time to revive (Kikwasi, 2013; Mallewo, 2014). With the increase in the size of projects as a result of greater infrastructure demands for socio-economic development, project managers require appropriate choice and use of CPMTT at each stage as they facilitate enhanced project planning, monitoring, and, control over the various project phases from design, construction, operation to decommissioning. At a conceptual phase, tools used include; WBS, Scope statement, Gantt chart, CPM, PERT, decision tree and analytical tools to assist in project selection, at project planning phase tools include: cost estimating and resource list for cost planning and cost-benefit analysis while EVM, change request, progress reports and inspections are commonly used at execution phase. Milestone chart has been referenced as crucial for any schedule driven objective organization in successful time management of a project (Milosevic et al. 2010; Petro, 2016). The construction industry is at the forefront as it converts resources into physical assets including the much needed physical infrastructure. This has been partly attributed to the failure in proper choice of CPMTT as per project phases.

The Tanzanian construction industry with specific reference to infrastructure projects has emerged to be a major sector for economic growth (Kikwasi and Sospeter, 2023). The United Republic of Tanzania (URT) (2022) reveals the construction sector growth of 4.3% from 14.1% in 2020 which results from ongoing construction works including construction and rehabilitation of roads, bridges and airports as part of DMDP projects. DMDP is a multi-facet infrastructure project within Dar es Salaam metropolitan area, whose main goal is to increase urban services and institutional capacity. The projects main focus was in infrastructure improvements and construction for priority roads including local and feeder roads to reduce congestion, and facilitate public transit and connectivity to low-income communities (World Bank, 2021).

While construction works differ in context, complexity, construction method and nature, DMDP projects come with a new direction of civil works which present the need for an advanced technology in terms of technical and its management. Despite the immense contribution of CPMTT to project success, there is limited empirical studies on the factors influencing the choice of CPMTT in infrastructure projects. With ever increasing new CPMTT as a result of fast development of the project management practice in developed nations, the variability in awareness of what tools project managers in developing countries actually apply and their perceived factors influencing their choices in realizing the iron triangle objectives of cost, time and quality is still a question.

Numerous factors driving selection and application of PMTT have been identified in developed nations in various sectors of economy including IT, business, manufacturing, and construction. For example, it was concluded that, the use of modelling tools and techniques in the area of project management is not widespread in practice (Doskocil, 2015); stakeholders' engagement, knowledge and skills set are critical success factors affecting project performance (Thawatchai et at., 2019), guidelines of using PMTT to mitigate delays (Alotabi et al., 2016). Furthermore, most of these studies have focused on the use of PMTT in building projects. Studies by Ismael et al. (2019) and Pellerin et al. (2018) have categorised factors affecting the choice and use of PMTT as internal and external factors. Each study adds up new factors depending on their contexts. They have focused on the development projects generally and others on the aftermath of PMTT application as a reactive approach to address project delivery issues. However, the uniform application of PMTT to all projects at all times has been highlighted by authors as a problem since each project is a unique endeavor, with its own constraints and limitations. Kerzner (2000) argued that lack of focus on the application of project management and project managers' discretion is among weaknesses in selection and use of CPMTT. Since project delivery fairly depends on appropriate choice of CPMTT and that government policies influence project practitioner's execution of infrastructure projects, they can only best apply CPMTT when critical factors are clearly understood and considered. It was therefore important to analyze the various factors influencing the choice of CPMTT in public infrastructure projects so as to improve project performance and delivery within the Tanzanian context.

2. Literature review

2.1 Project management in the construction industry

Project management tools and techniques have been described as a way to project success (Milosevic 2001; Sospeter and Awuzie, 2023). The Tanzania construction industry generated USD 6.7 billion in the year 2018 approximately 14% of the GDP compared to USD 4 billion in the year 2014, representing an increase of 68% (Tanzania Invest, 2023). According to Petro (2016) the number of project management tools exceeds 70 by far since the publication of the first few editions of the project management book of knowledge (PMBOK) Guide and numerous tools are developed and used as time goes. Henceforth, there was a need for adequate literature review to identify and include the most relevant tools for investigation based on previous studies. Time management tools selected for the study such as and not limited to Gantt charts, Bar charts and were drawn from literal sources notably Milosevic et al., (2010); PMI (2013) and Besner et al. (2008). Cost management tools such as cost estimating techniques, earned value management, cost change control system and performance measurement Petro (2016) and Fortune et al. (2011). Quality management tools such as Pareto diagram and control charts were drawn from a study by Besner et al. (2008). For the purpose of this study, the investigated

tools and techniques used in Time, cost and quality management of a project were evaluated as the most relevant and commonly used tools associated with construction project success. Various factors such as; size and duration of the project (Al Rawi et al., 2021; Thawatchai et at., 2019), the construction method, the nature of the project, the ability and knowledge of the Project Manager, involvement of stakeholders (Ponnappa, 2014), availability and accessibility of the appropriate tools (Sospeter et al., 2020) acknowledged as factors affecting CPMTT.

2.2 Factors affecting selection of Construction Project management tools and techniques

Factors influencing selection of PMTT have been identified by researchers. These factors are identified internal and external factors. Internal factors include; the type of project and the phase of the project lifecycle (PMI, 2013; Besner et al., 2008; Love et al., 2005), concept of success and strategic importance of the project (Dvir et al., 2004; Memon and Mohammed, 2011) , level of experience of the project team (Besner et al.,2004 ; Petro, 2016; Ayodele et al., 2015; Milosevic et al., 2010), the implementing organization (Xuana et al.,2021; Besner et al.,2008; Milosevic et al., 2010), the number of project stakeholders and their involvement (Diallo et al., 2005; Ponnappa, 2014), and the nature of project tools in the business or industry sector (Milosevic et al., 2001; Kerzner, 2000). Whereas, external environment factors include; political intervention (Ika et al., 2011, 2012; Akande et al., 2018; Nyangwara et al., 2015) and the technological and managerial capabilities have also been among the notable factors (Ofori, 2000; Xuana et al., 2021). Most of these studies are not specific to CPM Studies as have been carried out all around the world (Xuana et al., 2021; Al Rawi et al., 2021; Sospeter et al., 2020; Thawatchai et al., 2019 and Ponnapa 2014).

Numerous authors have endeavored to elaborate on the subject of PM tools and techniques application. For instance, Milosevic et al., (2010) argued that practitioners need to pay closer attention on which tools to use depending on the project phase cycle. The author emphasized that construction project management is directly related to project life cycle phases with each phase requiring unique and specific tools and techniques of implementation (PMI, 2013; Dvir et al.,1998; Besner et al., 2004). The experience of the project manager is also a key issue in effective application of PM tools and techniques. Proponents of this argument (Besner et al., 2004; Petro, 2016; Ayodele et al., 2015; Milosevic et al., 2010) stressed that experienced project managers have been observed to use project management tools at a higher frequency than inexperienced project managers. The nature of the tool has also been exposed as a defining factor in the application of PM tools, in their study of PM tools practice across UK, Australia, and Canada, (Fortune et al., 2011) concluded that the use of bar charts, Gantt charts is substantially higher across projects due to their simplicity nature. (Besner et al., 2004; Ika et al., 2011) had similar conclusion that the lack of specific training and resource support influenced many practitioners to use simple traditional methods in managing projects.

Stakeholders' involvement has been highlighted by (Diallo et al., 2005; Ponnappa, 2014) to influence the use of PM tools and techniques as a result of contradicting interest of stakeholders involved in development projects. Not only that, the effects of involvement of stakeholders especially in development projects in developing nations can be exacerbated by the state of political environment (Ika et al., 2012; Akande et al., 2018; Nyangwara et al., 2015). Stakeholders in the Australian construction project sector have a crucial role to play in cost management and their failure to execute their responsibilities adds to the chronic problem of cost overruns (Doloi, 2013). According to Ika et al. (2011) considering the fact that many tools such Gantt chart are rationally and efficiency-driven and that NPCs have to cope with political and social demands on project resources which can significantly hinder the project management. Nature of the organization influenced the selection and use of project management tools through the governance and decision making process (Prieto, 2017). Research studies undertaken by Xuana et al. (2021), Milosevic et al. (2010) and Besner et al. (2004) concluded that practitioners require the support of the organization in the selection and use of PMTT especially tools which require significant resource commitment and training. Table 1 summarizes factors influencing selection and application of CPMTT across the world.

Despite the available literature mainly focusing on PM tools application in various developed nations, where the context is different, procurement systems and even construction methods are different from the developing countries, none of them highlighted the criticality by analyzing the factors influencing the choice of CPM tools and techniques. For example, in the context of the Tanzanian industry, Mallewo (2014) expounded on the concept of Project management practice in building projects in Tanzania, the study significantly highlighted the planning, coordination and execution aspects of Project management using findings from questionnaire survey. Nonetheless, the study was limited as it did not explore the various project management tools and relevant factors influencing their selection and application. Similarly, Kikwasi (2013) elaborated on the various causes of project disruption and delays in Tanzanian construction projects. Among the findings, the poor application of project management was stated. The study was rather limited as it did not elaborate the factors leading to poor application of project management tools. Henceforth, it is important for this study to analyze the various factors that influence the choice of CPM tools and techniques in the unexplored developing context such as Tanzania industry.

3. Methodology

3.1 Research design, population and sample size

A cross-sectional research design attempts to gather information from practitioners on factors influencing the choice of CPMTT.

Table 1: Factors influencing selection and application of PMTT

S/No.	Factors influencing selection and application of CPMTT	Author/s
1.	Nature of the tool and easily accessible	Fortune *et al*., 2011; Ponnappa, 2014
2.	Easy to use	Milosevic *et al.* 2010; Love 2005
3.	Organization provision of training	Diallo *et al*., 2005; Prieto, 2017
4.	Organization provision of resource commitment	Besner *et al*., 2008; Diallo *et al*., 2005
5.	The tool commonly used	Besner et al.,2008 ; Fortune *et al*., 2011
6.	Number of people in the project	Milosevic *et al*. (2010); Ssenyange and Kudakwashe (2023)
7.	Stakeholders engagement	Doloi, 2013; Akande *et al.*, 2018
8.	External environment	Ika *et al*., 2011; Akande *et al*., 2018
9.	Nature of organization in training	Ismael *et al*., 2019; Al Rawi *et al*., 2021)
10.	Number of activities in a project	Garland, 2009; Nyangwara *et al*., 2015
11.	Organization norm in use of specific tools	Xuana *et al*., 2021; Ponnappa, 2014
12.	Organization provision of resources	Xuana *et al*., 2021; Al Rawi *et al*., 2021)
13.	Organization provision of guidance	Xuana *et al*., 2021; Prieto 2017
14.	Use of tool based on availability	Besner *et al*.,2008 ; Fortune *et al*., 2011
15.	To assist in planning a project	Akande *et al*., 2018; Sospeter *et al.*, 2020
16.	To assist in execution and controlling	Besner *et al*.,2008 ; Fortune *et al.,* 2011
17.	Use of tool to complete project within budget	Ismael *et al*., 2019; Ayodele *et al*., 2015
18.	Use of tool to complete project within quality	Ayodele *et al*., 2015
19.	Closure and orderly ending of a project	Besner *et al*., 2004; Al Rawi *et al.,* 2021)
20.	Use of tool based on usefulness	Ismael et al., 2019; Sospeter *et al.*, 2020
21.	Use of tool based on familiarity of past project	Fortune *et al.,* 2011
22.	Monetary value of the project	Ponnappa, 2014
23.	Use of tool based on education and training	Ponnappa, 2014; Ika *et al*., 2011
24.	To assist in idea generation and inception of the project	Sospeter *et al.*, 2020; Al Rawi *et al*., 2021

Descriptive survey research design using the sequential explanatory mixed research approach was adopted (Rowley, 2014; Saunders et al., 2016). This approach was used as it provides the quantitative advantage of analyzing the factors while generating more detailed information from the interviewee views on several attitudinal aspects from a qualitative approach (Yin, 2018; Kothari, 2014). Henceforth, the case study for the DMDP projects employing a mixed method was expected to provide a more in-depth description on the numerous factors in the context of Tanzanian public projects and the perception of stakeholders' role on the factors as observed by practitioners. Since there was no official list of practitioners involved in infrastructure projects, the population size could not be easily determined. The study population was composed of two groups, the first population included the project managers and project coordinators within the Dar es Salaam Metropolitan Development Project. The second intended population involved managers with experience in infrastructure projects. The study targeted 10 respondents for interview and 60 respondents from DMDP public infrastructure projects which were completed or ongoing at the time of the study. Due to a small population size, the overall population of 60 practitioners was used as a sample. In the project management study, Ismael and Pardon (2019) stated that total population sampling is a type of purposive sampling technique whereby the overall population is used as a sample because the population is small and manageable. This is done to increase response rates from the population and to obtain conclusive results.

3.2 Sampling techniques and sample size

Purposive sampling technique was employed in order to obtain valid and relevant information for the study (Saunders et al., 2016). The basis for selection of a respondent was due to the qualities the respondent possesses and the ability to provide relevant information (Yin, 2018). This method was crucial for the research to study sample of population with certain knowledge pertaining to the research. Snowballing sampling approach was used where suggestions of the most relevant people to participate in the study was through chain referral from DMDP project practitioners. According to DMDP, there are three municipalities of Kinondoni, Ilala and Temeke undertaking the DMDP projects with various work packages. Therefore, the DMDP participants in project management were the main focus of the study. Furthermore, since the study aimed at infrastructure public projects, the rationale for choosing respondents from such projects for the study was to obtain the most relevant data pertaining to the study objective. The interview and questionnaire data were collected from Dar es Salaam region whereby the DMDP project is being executed. This allowed to get first-hand information directly from practitioners in the project through face to face interviews. Furthermore, the region as the financial and economic capital of Tanzania has been a focal point of rapid infrastructural projects thus respondents with experience in role of project managers are highly concentrated in the region.

Data Collection was through questionnaire survey administered as the first step in the sequential explanatory approach to obtain descriptive data from respondents. The sample selected for the interviews was a total of 10 participants. The interview was administered to the three Chief Resident Engineers and seven assistant resident Engineers from DMDP. The selected members were relevant to the study since they are directly linked/involved in the management of the DMDP projects which is the focus case study of this research (Rowley, 2018). The involvement of project managers to the project was the main criteria in selecting the sample size for the interviews. According to Patton (2002) and Yin (2018) meaningful qualitative research using interviews is adequate between the thresholds of 5-50 interviews in relation to the specified study, hence the chosen sample is adequate. A similar sample size of 10 interviews was used by Ssenyange and Kudakwashe (2023) in their study on identification of project management practices in Tanzanian PPP building projects.

3.3 Data collection and questionnaire

A literature search was conducted in order to uncover the knowledge and identify factors influencing selection and application of CPMTT (Xuana et al., 2021; Al Rawi et al., 2021; Sospeter et al., 2020; Thawatchai et at., 2019 and Ponnapa 2014; Nguyen et al., 2016 and Ayodele et al., 2015). The information obtained from the reviewed studies related to the current study, guided the design of the structured questionnaire (Saunders et al., 2016). The questionnaire as a data collection instrument was developed to assess the factors influencing selection and application of CPMTT in Tanzania's public infrastructure projects. In total, 24 factors were extracted from literature of various countries and as illustrated in Table 1 formed the basis of the questionnaire design. The main reason for using previous factors is to provide an opportunity of comparing the findings with those from other studies (Sospeter, 2023). The 24 factors were listed and sent to 60 project management practitioners to rank those which are relevant to be adopted for the study.

The questionnaire was divided into two distinct sections: (1) Section 1 composed of the general demographic information on participating practitioner such as gender, educational background, and project management experience. To enable comparability of the information, the questions were arranged uniformly with prepared categories with various options for practitioner's selection. (2) Section 2 comprised of the rating and ranking of the 24 factors influencing the selection of construction project management tools and techniques. The questionnaire composed active and attribute variables. Twenty-four factors extracted from the literature formed a list of factors in the questionnaire for respondents to rate using active variables with the weighting of 5 for Most Agreed (MA), 4= Agreed (A); 3= Moderate (M); 2= Disagreed (DA); 1= Most Disagreed (MD).

Questionnaires were administered physically through face-to-face and 50 valid responses were received equivalent to 83% response rate as indicated in Table 2. Quantitative data collected from the questionnaire was coded, amended and analyzed by using IBM Statistical Package for Social Sciences (SPSS) version 25 and factor analysis was used to categorize the factors influencing selection and application of CPMTT into smaller groups or set of variables (factors) as suggested by Akande et al., (2018). Directed content analysis was used to analyze audio and written records from interviews in correlation with literature to attain comprehensive results. The method was suitable for the study as it helped to compare and contrast the compiled data resulting from interviews with concepts and theories from previous studies.

4.0 Data presentation and Analysis

4.1Repondents response rate

From the 60 questionnaires administered to respondents in capacity of project manager and 10 to Resident Engineers and Assistant Engineers in similar infrastructure projects, 40 questionnaires from Project Managers and 10 from the Engineers were returned equivalent to 83% of total response as indicated in Table 2. In the second step, Oral interview was conducted with DMDP project respondents composed of Resident engineers, Assistant resident engineers and project coordinators (PIU), a total of 10 interviews were successfully conducted in a period of 7 weeks.

4.2 Profile of respondents

Table 3 provides the profile of the questionnaire respondents, while Table 4 provides the interviewee's

profile according to the following individual attributes: Interviewees position as held, education and experience levels. The experience and education level of practitioners is an important factor in ascertaining the reliability of their response in relationship to Project management practice and specifically tools application. Examination of Table 3 shows that majority respondents had a strong education background, varying ranges of experience and designation backgrounds. Education-wise, the majority (64%) of the respondents had a Bachelor degree. While the remaining 36% have a Master's degree which is much higher than the first degree, implying that respondents have adequate educational background. Generally, 58% of respondents have experience of over 10 years, 22% have experience of between 6 to 10 years, whereas only 20% have experience of 1 to 5 years in the construction industry. Furthermore, respondents indicated to be well experienced in terms of the roles and responsibilities relating to their individual current positions with 38% stating to have an experience of more than ten years in the role of project manager. 32% of respondents have between 6 and 10 years of experience in project management roles.

Table 2: Distribution and attained Questionnaire responses

Respondents	Distributed	Returned	Percentage of success
Resident Engineer (DMDP)	3	3	100%
Assistant Resident Engineer (DMDP)	7	7	100%
Project managers in DMDP and similar projects	50	40	80%
Total (respondents outside DMDP)	**60**	**50**	**83%**

In addition, only 30% have an experience of below 5 years in the role of project manager. Furthermore, 67% of Project coordinators in the DMDP equivalent to 2 out of 3 from PIU have experience of 1 to 5 years in their role of project coordination, whereas 33% equivalent to 1 out of 3 has experience of 6 to 10 years. These results indicate the practitioners are well experienced in their individual roles and associated issues that come with the roles thus viable respondents for the study. The composition of respondents was divided into foreign and local practitioners firm whereby 14% of respondents were foreign firms while 86% were local practitioners. The presence of foreign practitioners' firm in the respondents' composition indicate the potential of the findings to compare and contrast the practical application of project management tools and techniques between the foreign and local practitioners.

Table 3: Profile of questionnaire respondents

Variables	Categories	Frequencies	Percentages
Experience in the Construction industry	Less than 5 years	10	20%
	6-10 years	11	22%
	Over 10 years	29	58%
	Total	**50**	**100%**
Experience in position of Project manager	Less than 5 years	15	30%
	6-10 years	16	32%
	Over 10 years	19	38%
	Total	**50**	**100%**
Educational qualification	Diploma	0	0%
	Bachelor's degree	32	64%
	Master's degree	18	36%
	Ph.D	0	0%
	Total	**13**	**100%**
Professional background	Civil engineer	35	70%
	Quantity surveyor	9	18%
	Construction Manager	4	8%
	Architect	2	4%
	Civil technician	0	0%
	Total	**50**	**100%**
Nature of firm	Local	43	86%
	Foreign	7	14%
	Total	**50**	**100%**

Table 4: Profile of interviewees

Interviewee	Designation of Respondents	Nationality Status	General experience	Experience in current position	Education level
A	ARE-Temeke	Local	Over 10 yrs	6 to 10 years	Master's
B	RE-Kinondoni	Local	over 10 yrs	over 10 years	Master's
C	ARE-Kinondoni	Local	Over 10 yrs	6 to 10 years	Bachelor
D	ARE-Ilala	Local	Over 10 yrs	Over 10	Bachelor
E	PIU-Kinondoni	Local	Over 10 yrs	6-10 years	Master's
F	ARE-Ilala	Local	Over 10 yrs	6-10 years	Master's
G	ARE-Temeke	Local	Over 10yrs	Over 10 years	Bachelor
H	RE-Temeke	Foreign	Over 10 yrs	Over 10 years	Master's
I	ARE-Temeke	Local	Over 10 yrs	Over 10 years	Master's
J	ARE-Kinondoni	Local	Over 10 yrs	1-5 years	Bachelor
K	PIU-Temeke	Local	Over 10 yrs	1-5 years	Master's
L	PIU-Ilala	Local	Over 10 yrs	1-5 years	Bachelor
M	RE-Ilala	Foreign	Over 10 yrs	Over 10 years	Master's

Key: RE: Resident engineer. ARE: Assistant Resident engineer. PIU: Project Implementation Unite coordinator

4.4 Results of Factor Analysis – Components 1 to 4

Table 5 presents result on factor analysis. Rotated component matrix of all combined components is 84.106% which is above 50%. The higher the variance in percentage the higher the influencing factor.

Table 5: Results of Factor Analysis

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
Fulfillment of project objectives (37.454% Variance)				
Use of tools to complete projects with quality	.903			
To assist in the execution and controlling of the project	.903			
Use of tools to complete the project within budget	.903			
To assist in the planning of the project	.903			
Use of tools to complete project within time	.789			
The tool is easily accessible (i.e does not require substantial resources commitment)	.777			
The number of people in the project	.763			
The tool is traditional (i.e commonly used across projects)	.756			
Use of tool based on Education and training	.718			
To assist in closure and orderly ending of the project	.709			
Organization support (21.435% Variance)				
The tool is relatively easy to use (i.e does not require any particular training, skills or substantial inputs)		.871		
Organization provision of training on use of tool		.865		
Organizations provision of guidance/manual on use of tools		.848		
The involvement of stakeholders		.816		
Organizations provision of resources for ease access of tools		.783		
The monetary value of the project		.726		
Project environment and idea generation (15.394% Variance)				
The external environment aspects of the project (i.e political influence)			.812	
To assist in idea generation and inception of the project			.686	
The number of activities in a project			.684	
The duration of project			.674	
Ease of access and usefulness of tool (9.823% Variance)				
Organizations norm in use of specific tools and techniques				.579
Use of tools based on availability and ease of access				.732
Use of tools based on usefulness				.576

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 8 iterations.

5. Discussion of the Factors influencing the choice of CPMTT

5.1 Fulfilment of Project Objective Factors

Component 1: fulfillment of project objective factor was determined to influence the choice of CPMTT in Tanzania public infrastructure projects as a category explained by 37.454% total variance based on the dataset in Table 5. The component has 10 items; Use of tools to complete the project within quality, to assist in execution and controlling of the project, Use of tools to complete the project within budget, to assist in the planning of the project, Use of tools to complete the project within time, the tool is easily accessible, the number of people in the project, the tool is commonly used across projects, use of tool based on education and training and to assist in closure and orderly ending of the project with factor loadings of 0. 903, 0. 903, 0. 903, 0. 903,0.789, 0.777, 0.763, 0.756, 0.718 and 0.709) respectively.

Time, cost, and quality form an iron triangle of elements that have been appreciated by many researchers to contribute to project success (Doskocil, 2015; Thawatchai et al., 2019). The use of tools to complete the project within quality, budget, and time is evidenced in literature as a factor influencing selection of CPMTT (Ismael et al., 2019; Fortune et al., 2011; Adoyele et al., 2015). The tools aim to assist in executing the project by speeding it up and enhancing project output. Assist in the planning of the project is a factor influencing the choice of CPMTT. Planning is an important aspect of that influence the choice of CPMTT because of fast-tracking features and is likely to be preferred.

5.2 Organization Support and Training Factors

Component 2: organization support and training was determined to influence the choice of CPMTT in Tanzania's public infrastructure projects as a category explained by 21.425% total variance based on the dataset. The component has 6 items: The tool is relatively easy to use (i.e does not require any particular training, skills, or substantial inputs), the Organization provides training on the use of the tool, the organization provision of guidance/policy/manual on the use of tools, the involvement of stakeholders, Organizations provision of resources for ease access of tools and the monetary value of the project with factor loadings of 0.871, 0.865, 0.848, 0.816, 0.783 and 0.726 respectively.

Organizations' provision of resources for ease of access to tools implies that project managers in organizations that have policies to foster project management tools for productivity tend to influence support in the accessibility and use of various project management tools. This includes software tools that tend to require financial support to acquire as a result of the high costs involved. Notable literature such as Besner et al. (2008) and Fortune et al. (2004) concluded with similar findings that resources required to access PM tools can greatly affect the ability and frequency of choosing the PM tools. Furthermore, Besner et al., (2008) established in their investigation on PM practice that tools such as Gantt charts display a significantly higher use among practitioners because individuals can use such tools without any organizational investment or support. However, the use of database tools such as Monte Carlo simulation does require significant organizational resources and support. Interviewee G stated;

"The company needs to assist the project manager especially when using tools that do not come with the computer (Microsoft Office package). In our firm, we prefer to use Merlin for project scheduling hence we have office desktop computers for our engineers to use since the program is not readily available in other platforms."

The emergent implication of the finding is that project managers tend to frequently choose tools that can be easily accessible without significant resource commitment, especially when the company does not provide resources for ease of access. This fact complements findings from the survey whereby tools such as Microsoft Office project display a significantly higher use than others such as CCPM, Primavera, and Monet Carlo simulation. The reason behind this is that the former can be easily accessed as it comes in the Microsoft Office package compared to the latter tools which would require resource commitment in not only the purchase of the tools but also the provision of training in use.

Organization provision of training on the use of tools is identified in the literature as a factor influencing the choice of tools as similarly asserted in studies such as Xuana et al. (2021) and Fortune et al. (2011). Training includes a range of continuous development programs initiated by the firm or other professional organizations that assist project managers in not only the selection of compatible tools in line with project demands but also training and guidance for project managers in the appropriate application of various tools (Milosevic et al., 2010). Project management training offers lots of benefits and companies that are well-structured have taken advantage of this (Sospeter et al., 2022). For instance, in their study on the importance of project management training asserted that training tailored to the organization's goal contributed to the organization through the provision of an improved level of project risks and also offered resource control (Ponnappa, 2014). The significance of training is further noted as Al Rawi et al. (2021) opined that a well-organized and effective professional development program is one of the most important assets of a company, directly impacting its fruitfulness and long-term viability as a company.

Interviewee C stated:
"Yes, the organization provides support and training, but I have to show them why I need the tool and how it can help to accomplish my tasks because support in training or purchasing of these software involves costs incurred by the firm, they must see value for money."

The respondent further highlighted the process of how the organization supports and influences the use of tools as follows:

"The user will go to the management of the firm and tell them we think a certain software is useful for our project, then they will sit together to see if there is an alternative or if this is the best tool to be used. But it begins with the user knowing which tool he needs to accomplish his tasks to get the assistance (support) he needs from the firm management."

The findings highlight the immense role of training in improving the performance of project managers specifically tool applications. Training is also significant in ensuring continuous improvement in the management process as practitioners have access to workshops and learning programmes. This leads to a better understanding and use of project management tools, catering to the construction environment.

Involvement of stakeholders

Involvement of stakeholders refers to the influence that various stakeholders have as a factor influencing the application of Project management tools. Ponnappa, (2014) argued that stakeholder management will also be a challenge when the organization has to adopt new tools and techniques. Due to differing interests, backgrounds, and experiences between stakeholders in a project, convincing each stakeholder of the relevance of certain tools and techniques can become a challenge. The findings of this study agree with those of Diallo et al. (2005), Ponnappa (2014), and Ocharo et al. (2018) which highlighted the influence of multiple stakeholders in development projects executed in developing nations, whereby the varying degree of interest between the NPC (National project coordinators), financier, technical advisors, and client can hinder the role of Project managers. According to the findings, the client has the major influence in the project management process, this extends from the conception stage about the term of reference and extends to the design and execution phase with the choice of tools.

Interviewee H stated that;

"I proposed to use PRIMAVERA during the first kick-off meeting to manage project progress but it was declined by the client due to the lack of awareness by the client and the Contractor. The client instructed that the Microsoft project is to be used."

The aforementioned project manager who is a foreigner has an extensive background in project management in developed nations such as Korea and Saudi Arabia. From the practice, PRIMAVERA was the most widely used tool based on its extensive functions, nonetheless, the proposal to adopt the tool for management in the DMDP project was declined by the client. The implication of this is the Client has considerable influence on the manner of managing the project, hence a consensus between the client and project management team needs to be reached on the best set of tools for managing the project based not only on the client's preference but the effectiveness of the tools.

Organizations' provision of guidance/policy/manual on the use of tools is noted in the literature as one of the factors influencing the application of CMPTT (Prieto, 2017). Organizations with policies and guidance ensure that practitioners in the firm are aware of the basic tools approved by the management to acquire the desired output in each task. In addition, the presence of policy and guidelines for project management tools application improves productivity as it creates uniformity in the application of tools among practitioners, reduces the erroneous application of tools among recruits, and provides a baseline of output expected from each operation. For instance, Alrajhi et al. (2020) in their study on the role of policy in project management in Saudi Arabia concluded that policy is important in project management because it not only protects the company through a proactive policy but also provides a framework that defines the rules of operation for the users of project management tools.

Interviewee B stated that;

"We have a company guideline (policy) that every recruit (employee) will be informed of during the first few months (probation period) showing the software tools we expect them to use and the formats required for doing their tasks. This helps us to have uniformity in our final output and also facilitates quick learning for the new staff."

The finding implies that policy development is crucial for firms in ensuring recruits possess the required level of guidance in the choice of effective tools to produce the desired outputs in the management of the project.

5.3 Project environment and idea generation of the project factors

Component 3: The project environment and idea generation of the project factor was determined to influence the choice of CPMTT in Tanzania public infrastructure projects as a category explained by 15.394% total variance based on the dataset. The component has 4 items; the project environment, to assist in idea generation and inception of the project, the number of activities in a project, and the duration of the project with factor loadings of 0.812, 0.686, 0.684, and 0.674 respectively. Idea generation is a process used to generate options whether they are tangible or not hence a factor influencing the choice of CPMTT. It involves gathering ideas among various project teams before implementing the plan. Appropriate tools are needed to provide support, simplification, and consolidation of stakeholders' ideas towards the agreed plan of the project. An interviewee attested that "at the very early stage of the project, lots of ideas with more alternatives are expected to meet clients' expectations". The idea generation aids in informing project-related decisions (Doskocil, 2015; Mtanga and Rwelamila, 2019). Therefore, the tools are used as decision support during the design stage as they encourage thinking, joint efforts, and generation of options around issues. While external environment factors always affect the project externally, it provides room for challenges in infrastructure project management as a result of differing socio-cultural backgrounds and practices (Kikwasi and Escalante, 2020; Diallo et al., 2005). In addition, the significantly different political

climate may influence the choice of CPMTT in Tanzania public projects compared to other developing nations such as Kenya and Nigeria where similar studies such as (Akande et al., 2018; Nyangwara and Datche 2015) have been conducted. The results imply that, the environment in which the project is in and the ability to assist in providing alternatives influence the choice of CPMTT.

5.4 Easy access and usefulness of tools factor

Component 4: easy access to tools and usefulness was determined to influence the choice of CPMTT in Tanzanian public infrastructure projects as a category explained by 9.832% total variance based on the dataset. The component has three items: use of tools based on availability and ease of access, organizations norm in use of specific tools and techniques, and use of tools based on usefulness with factor loadings of 0.732, 0.579, and 0.576 respectively. The tool is relatively easy to use and is among the factors influencing the choice of CPMTT as it does not require any particular training, skills, or substantial inputs. Tools' relative ease of use implies the inherent character of the project management tool to cater to various users, some with the most basic tool of operation (Mtanga and Rwelamila, 2019). This can be observed in the contrasting level of use between bar chart tools like Gantt charts and database tools such as Montecarlo. In the case of the former, both project managers and intended clients prefer the tool as it is simple to understand and use compared to the other work programming tools.

The results of the study are aligned with various studies on PM tools, notably (James 2003; Ogbonna et al., 2018). The authors stressed that project managers prefer to use tools that can be easily grasped and applied to produce desired output, but also provide easy presentation for understanding of other stakeholders. Ponnappa (2014) asserted in their findings regarding scheduling management tools that the Gantt chart provides easy and convenient monitoring of job progress and has become a veritable tool in representing project activities for easy assimilation by a wider audience. Xuana et al. (2021) similarly concluded that the Gantt chart is immediately intelligible to people with no knowledge of network diagrams. The results imply that the simplicity of the tools and the ease with which users can apply them to achieve desired deliverables is a crucial factor influencing the selection and use of a tool.

6. Conclusion and implications

The purpose of this research was to analyze factors influencing the choice of PM tools and techniques in Tanzania's public infrastructure projects. Using factor analysis of the factors influencing the choice of CPMTT, four groups of organization support, ease of access and usefulness of tools, fulfillment of project objectives, and project environment and idea generation were determined. The results of the four groups obtained were highly influenced by: the use of tools to complete the project within quality, the use of tools to complete the project within budget, to assist in execution and controlling of the project, assisting in planning of the project (component 1) , the tool is relatively easy to use, organization provision of training on use of tools, organization provision of guidance on use of tools, involvement of stakeholders (component 2), project environment, to assist in idea generation and inception of the project (component 3) and use of tools based on availability and ease of access (component 4).

The contribution of this study is through the synthesis of the 24 factors identified from the literature into groups of four components (a factor analysis approach). This taxonomy provides more insights on the understanding of the factors influencing the choice of CPMTT and critical assessment of various stakeholders' role in projects. Further, project managers tend to frequently choose tools which can be easily accessible without organization significant resource commitment. The findings could be used as a guide for project practitioners to critically assess the areas of weakness and select CPMTT that will help to address those weaknesses hence improved project delivery. Project managers are called to re-imagine the project needs based on priority and select the CPMTT that satisfy the needs such as time, cost, quality (project objectives) and innovation (idea generation) rather than using their discretion based on experience, skills and perceptions as crucial factors influencing the choice of CPMTT.

Limitations and areas for further study

First, the study was restricted to practitioners within the DMDP infrastructure projects within Tanzania. Therefore, the findings may not be generalized to different countries with contradicting political settings and practices. Second, the study did not study the extent of influencing factors and their effect on project performance nor the differences on registration status of respondents between Local or foreign firms. Future study should focus on assessment of project stakeholders' roles and how they influence CPM tools selection in in public-infrastructure projects.

References

Akande, O.K., Olagunju, R.E., Aremu, S.C. & Ogundepo, E.A. (2018). Exploring Factors Influencing of Project Management Success in Public Building Projects in Nigeria. YBL *Journal of Built Environment*, 6 (1), 47-62.

Al-rawi, O, Varouqa, F., Al-muhanna,R. & Amer, A. (2021). Factors Influencing the Productivity of Excavation Works for Construction Projects in Jordan. *International Journal of Civil Engineering and Technology*, 12(4)

Alrajhi, E. & Khayya, M. (2020). The Role of Policy in Project Management Stages. *International Journal of Engineering and Techniques*, http://dx.doi.org/10.29126/23951303/IJET-V6I6P6.

Ayodele, V. M., Olatunji, S.O., Oke, A.E. & Akanni, P. O. (2015). Project Management Tools Application For Construction Works Project Planning In Nigeria, Paper Presented At The Nigerian Institute Of Quantity Surveyors: 2nd Research Conference – Niqs Recon2 1st To 3rd September 2015.

Besner, C. & Hobbs, B. (2004). An Empirical Investigation of Project Management Practice: In Reality, Which Tools do Practitioners Use?, Paper presented at PMI Research Conference 2004, London, UK.

Chemuturi, M. (2013). Mastering IT Project Management: Best Practices, Tools and Techniques, J.Ross Publishing.

Chileshe, N. & Kikwasi, G.J. (2014). Critical success factors for implementation of risk assessment and management practices within the Tanzanian construction industry, *Engineering Construction and Architectural Management*, 21(3), 291-319.

Diallo, A. & Thuillier, D. (2005). The success of international development projects, trust and communication: an African perspective. *International Journal of Project Management*, 23(1), 237-52.

Doloi, H. (2013). Cost Overruns and Failure in Project Management: Understanding the Roles of Key Stakeholders in Construction Projects. *Journal of Construction Engineering and Management*, 139(3), 267-279.

Dvir, D., Lipovetsky, S., Shenhar, A., & Tishler, A. (1998). In search of project classification: a non-universal approach to project success factors. *Research Policy*, 27(1), 915-35.

Dvir, D. & Lechler, T. (2004). Plans are nothing, changing plans is everything: the impact of changes on project success. *Research Policy*, 33, 1-15.

Fortune, J. & White, D. (2011). Looking again at current practice in project management. *International Journal of Managing Projects in Business,* 4 (4) 553-572.

Ika, L.A., Diallo, A., & Thuillier, D. (2010). Project management in the international development industry, The project coordinator's perspective. *International Journal of Managing Projects in Business,* 3 (1), 61-93.

Ika, L.A. (2012). Project Management for Development in Africa: Why Projects Are Failing and What Can Be Done About It. *Project Management Journal,* 43, (4), 27-41.

Ismael, C.E., & Pardon, C., Project Management Tools and Techniques (T&T) Usage in Building Sector Companies in Cartagena City. Conference paper, 17th LACCEI International Multi-Conference for Engineering, Education, and Technology, http://dx.doi.org/10.18687/LACCEI2019.1.1.153

Ismail, A. & Rashid, K. (2009). The use of Project Management Software in Construction Industry. *Journal of Applied Sciences* 9(10), DOI:10.3923/jas.2009.1985.1989

James, M.W. (2003). Gantt charts: a centenary appreciation, *European Journal of Operational Research*. https://www.researchgate.net/publication/2917166_Gantt_Charts_A_Centenary_Appreciation.

Kerzner, H. (2000). Applied Project Management: Best Practices on Implementation, John Wiley & Sons.

Kikwasi, G. & Escalante, C. (2020). The Construction Sector in Tanzania In: Mining for Change: Natural Resources and Industry in Africa. Edited by: John Page and Finn Tarp, Oxford University Press. http://dx.doi.org/10.1093/oso/9780198851172.003.0012.

Kikwasi, G. (2013). Causes and Effects of Delays and Disruptions in Construction Projects in Tanzania. *Australasian Journal of Construction Economics and Building*, 01(02) http://dx.doi.org/10.5130/ajceb-cs.v1i2.3166.

Kikwasi, G.J. & Sospeter, N.G. (2023). The nexus between monetary and fiscal policies and construction output in Tanzania. *Acta Structilia.* 30(1), 34-61,

Kothari, C., & Garg, G. (2014). Research Methodology: Methods and Techniques (3rd ed.). New Delhi: New Age International (P) Limited., Publishers.

Love, P.E., Edwards, D.J., & Tse, R. (2005). Time–Cost Relationships in Australian Building Construction Projects. *Journal of Construction Engineering and Management*, 2(187) 131-142.

Mallewo, A. (2014). Assessment of Application of Project Management Concepts in Building Projects in Tanzania (Case study Building Projects in Dar es Salaam), un published Master's Thesis, Author, Dar es Salaam.

Malongo, J. K. (2015). Board Performance for Year 2014 and Feedback from ACM 2014 Recommendations'. Proceedings of CRB Annual Consultative Meeting 2015 Challenges and Future Perspectives of the Construction Sector towards Attainment of Vision 2025. Dar es Salaam, 14–15 May, 1–30.

Memon, A.H., & Mohammad, Z.R. (2011). Resource-Driven Scheduling Implementation in Malaysian Construction Industry. *International Journal of Sustainable Construction Engineering and Technology*, 1(2), 77-90.

Milosevic, D., & Inman, L. (2001). Impact of Project Management Standardization on Project Effectiveness. *Engineering Management Journal*, 13 (4), 9-16.

Milosevic, D., Iewwongcharoen, B. & Patanakul, P. (2010). An empirical study on the use of project management tools and techniques across project life-cycle and their impact on project success. *Journal of General Management,* 35(3), 41-65.

Mtanga N. C & Rwelamila, P. D. (2019). Challenges affecting the Performance of Virtual Project Teams (VPTs) in South Africa, Towards industrialized Africa; Opportunities and Challenges, in 20th IAABD Conference, 8 – 11th May, 2019, Dar salaam, Tanzania, pg 497-509. ISBN: 978-0-620-83689-0

Mullungu, B. M., & Baitani, M. (2007). Challenges Facing the Contracting Industry. In the Proceeding of Contractors Annual Consultative Meeting: 10 Years of CRB: Empowering Contractors to Meet the Challenges Ahead, Dar es Salaam.

Nguyen, L.H. (2020). Empirical Analysis of a Management Function's Failures in Construction Project Delay. *Journal of Open Innovation Technology Market and Complexity*, 6(2), 26.

Nyangwara, O.P. & Datche, E. (2015). Factors Affecting the Performance of Construction Projects: A Survey of Construction Projects in the Coastal Region of Kenya. *International Journal of Scientific and Research Publications*, 5 (10).

Ocharo, R.N. & Kimutai, G. (2018). Project Management Practices And Implementation of Power Projects In Kenya. *International Academic Journal of Information Sciences and Project Management*, 3(1), 28-46.

Ofori, G. (2000). Challenges of Construction Industries in Developing Countries: Lessons from Various Countries. Fraunhofer Information Center for Planning and Building, https://www.irbnet.de/daten/iconda/CIB8937.pdf.

Ogbonna, A. C., Amade, B., Ononuju, C. N, Nwakanma, I. C. & Okwara, I. D. (2018). Application of Project Management Control Mechanisms in Construction Projects: A Case of Port harcourt, Rivers State, Nigeria. *European Project Management Journal*, 8 (1) 40-54.

Pellerin, R. & Perrier, N. (2018). A review of methods, techniques and tools for project planning and control. *International Journal of Production Research*, 57 (2), 1-19.

Petro, Y. (2016). Effect of project management tools and techniques on project success, Paper presented at First UAE project management conference, Conference paper, https://www.researchgate.net/publication/295076023.

Ponnappa, G. (2014). Project Stakeholder Management. Project Management Journal, http://dx.doi.org/10.1080/10429247.2002.11415180.

Project Management Institute (2004). Project Management Body of Knowledge (3rd edition). Newton Square, PA: Author.

Prieto, R. (2017). Expanding Project Management Frameworks to Address Today's Challenges. *Journal of Construction Engineering and Management*,143 (9), 127-139.

Project Management Institute INC (PMI). (2013). The High Cost of Low Performance, PMI's Pulse of the Profession.

Rowley, J. (2014). Designing and Using Research Questionnaires. *Management Research Review*, 37 (3), 308-330.

Saunders, M, Lewis, P. & Thornhill, A. (2016). Research Methods for Business Students, 7th Ed, Pearson Education Limited, Harlow

Sospeter, N. G & Awuzie, O. B. (2023). Capital Budgeting implementation by Public Sector Construction Firms in Tanzania's housebuilding Industry: An Exploratory study. *Journal of Construction in Developing Countries*, 29(1), 87-109.

Sospeter, N. G., Rwelamila, P. D. & Gimbi, J. (2020) Critical Success Factors for Managing Post Disaster Reconstruction Projects in Angola. *Journal of Construction Economics and Building,* 20 (3), 37-55.

Sospeter, N. G., Rwelamila, P. D. & Mtanga, C. N. (2022). The Hexagon of Driving Forces for Improving Performance of Virtual Project Teams (VPTs) in Emerging Economies – the case of South Africa. *The Journal of Modern Project Management*, 9(3), 102-123.

Ssenyange, K. & Kudakwashe, C. (2023). Impact of Leadership Styles on Government Construction Project Success: A Structural Equation Modelling Approach. *Journal of Construction Business and Management*. 6(2), 11-26.

Tanzania Invest. (2023). Tanzania Construction, accessed from https://www.tanzaniainvest.com/construction on 20th January 2024.

JCBM (2024) 7(4) 46-56

University of Cape Town

Journal of Construction Business and Management

http://journals.uct.ac.za/index.php/jcbm

Understanding Corruption in the South African Construction Industry

[1]Manqoba S.M. Soni and [2]John J. Smallwood

[1&2] Department of Construction Management, Nelson Mandela University, South Africa

Received 13 February 2024; received in revised form 12 April 2024 and 12 May 2024; accepted 3 August 2024
https://doi.org/ 10.15641/jcbm.7.1.1522

Abstract

Corruption persists in the construction industry, impeding service delivery. This study aimed to understand corruption among practitioners within the South African (SA) construction industry. The study included practitioners in the construction industry (private and public sector) operating across seven associations in Johannesburg, SA. Participants were recruited using a snowball sampling method. Participants completed an open-ended, semi-structured interview (12 questions), conducted face-to-face and took 45 to 60 minutes. There were a total of 11 participants. Respondents felt collusion exists due to poor ethics and that poor ethics among built environment stakeholders result in unethical behaviour. There was consensus that corruption affects the economic growth of SA and that small, micro, and medium enterprises are vulnerable when the economy performs poorly. Participants agreed that corruption could result in delayed or no completion of projects, affect quality standards and that incompetent contractors result in poor performance. Participants felt that corrupt practices result in government departments paying contractors late. On the other hand, whistleblowing rarely occurs due to its risky nature. There was agreement that unethical practices affect securing contracts during procurement and that the manipulation of procurement processes results from a lack of transparency. Corruption is a challenge in the SA construction industry and needs to be eliminated..

Keywords: construction research; corruption; South Africa; construction industry

1. Introduction

The construction industry has made substantial contributions to South Africa (SA). The industry is known to contribute to developing infrastructure, providing service delivery, and ensuring the well-being of the general population. However, acts of corruption overshadow the sector's substantial impact (Lambsdorff, 2008). Compared to other sectors, the construction industry is one of the most corrupt sectors (Goldie-Scot, 2008; de Jong, Henry & Stansbury, 2009), with corruption persisting despite efforts to eliminate it. Corruption is so pervasive in the SA construction industry that even firms and government officials engage in it (Bowen et al., 2007). Corruption has been reported as unethical practices, collusion, and bribery (Bowen et al., 2007; Ibem & Laryea, 2017).

Corruption threatens the country's improvements because it utilizes government resources to cater to the needs of individuals instead of the general population (Heidenheimer & Johnston, 2011; Iyanda, 2012; Ángel, 2016). In service delivery, there have been reports of over-claiming for undelivered services (Bowen et al., 2007). Mandatory service delivery is driven by corruption, resulting in the inaccessibility of basic services.

Although it is an unintended consequence, corruption can threaten infrastructure (Le et al., 2014). This occurs when contract recipients are selected in an undue process instead of based on skills (van Klinken & Aspinall, 2011), which might result in using sub-standard material and inexperienced workers. Given that corruption in the construction sector endangers lives, it needs to be eradicated. Therefore, this study aims to understand corruption among practitioners within the SA construction industry.

2. Literature Review

2.1 Economic Growth

Research suggests corruption has a direct negative impact on the growth of the economy (Links & Haimbodi, 2011; Swaleheen, 2011). Lower levels of corruption lead to economic growth (Bai et al., 2013). Countries that perform well economically often have limited corruption

[1] Corresponding Author
Email address: manqobas@ilohm.co.za

(Ali & Kamaruzzaman, 2010; Alon, Li & Wu, 2016). Corruption may significantly contribute to many developing countries' low economic growth rates (Olken, 2007). This negative relationship between corruption and economic growth leads to social and ethical problems, manifesting themselves in society through increasing levels of poverty (Lewis, 2011). Therefore, corruption can harm a country's economic growth (de Vaal & Ebben, 2011; Nguyen & Van Dijk, 2012). Specifically, corruption reduces public expenditure output, misrepresents the allocation of resources, and lessens the number of investors and the amount invested (Grabova, 2014). Although the construction sector is reported to be among the most corrupt sectors worldwide, the construction sector contributes positively to the economy. Therefore, eradication of corruption can assist in improving economic growth.

2.2 Performance and Quality

Unethical selection of the contract of the recipient can lead to a reduction of the quality of material used and quality (van Klinken & Aspinall, 2011) since the contract is not awarded based on expertise. False awarding of contracts ultimately affects the quality of buildings. For instance, in Nigeria, there have been numerous reports of building collapses (Olusola et al., 2011; Agwu, 2014; Ogunde et al., 2017), which killed people and destroyed existing properties (Olusola et al., 2011; Agwu, 2014). In Angola, medical staff and patients were requested to vacate the general hospital in Luanda when huge cracks appeared all over the two-story building and walls were crumbling (de Morais, 2010). These collapses or structural failures were mainly due to using sub-standard material due to corruption (Agwu, 2014; Ogunde et al., 2017). It is important to note that falsely awarded contractors may end up executing projects at a sub-standard level (van Klinken & Aspinall, 2011; Abdul-Rahman et al., 2014). Therefore, building collapses or failures are a severe indirect consequence of corruption (Lewis, 2011; Olusola et al., 2011; Agwu, 2014; Nguyen & Chileshe, 2015). Concerningly, using sub-standard materials violates building regulations, and the violation is possible due to lack of supervision (Kuta, 2021).

2.3 Delayed Payments

Late payments or nonpayments are common in construction (Fugar & Agyakwah-Baah, 2010; Baloyi & Bekker, 2011; Abdul-Rahman et al., 2014; Ngomi, 2017). For instance, in Malaysia, late payments were a common challenge in the construction industry. As a solution, the 2012 Construction Industry Payment and Adjudication Act (CIPAA) was established (Abdul-Rahman et al., 2014). However, the issue of late payments or nonpayments still occurs despite the 2012 CIPAA (Abdul-Rahman et al., 2014). In Zambia, delayed payments by property owners are a significant driver of corruption and lack of commitment by contractors (Ngomi, 2017). Moreover, contractors in Ghana face the harsh reality of not being paid on time by their employers and not being compensated for late payments to cap the loss (Laryea, 2010). In some cases, the slow payment culture is embraced by government officials because bribes (monetary or gifts) are then given to government officials as an incentive to speed up the process (Bowen et al., 2007; Méon & Weill, 2010; Mizoguchi & Van Quyen, 2014). However, as much as corruption can result in faster service delivery, corruption causes sustainable service delivery to suffer due to government officials withholding payments until they receive bribes (Bowen et al., 2007).

2.4 Procurement Processes

Procurement is a process that involves goods, services, and works acquired by public or private institutions from external sources (Boahene & Nani, 2015). The issue with corruption in construction is that it manipulates procurement systems (Ateljevic & Budak, 2010; Ameyaw et al., 2012; Nguyen & Chileshe, 2015; Gottschalk & Smith, 2016; Knack et al., 2019) and affects resource allocation all over the world (Palguta & Pertold, 2014). Despite numerous efforts to alleviate corruption, it continues to rise in public procurement (Tabish & Jha, 2012). For example, government officials manipulate public procurement systems, and this manipulation is one of the critical factors that cause failure in construction projects (Nguyen & Chileshe, 2015). Public procurement is affected by corruption regardless of policies, procedures and funds (Gottschalk & Smith, 2016). In Ghana, manipulation of the procurement process is still prevalent despite the existence of the Ghanaian Public Procurement Law 2003 (Act 663) (Ameyaw et al., 2012). Corrupt procurement practices occur as a result of poor management practices in organizations (Basheka & Bisangabasaija, 2010; Boahene & Nani, 2015), involvement of government (Gottschalk & Smith, 2016), weaknesses in institutional structures (Boahene & Nani, 2015), lack of transparency (Boahene & Nani, 2015), and poor communication, monitoring and evaluation (Basheka & Bisangabasaija, 2010).

2.5 Small, Micro, and Medium Enterprises

The risk of corruption is higher for small, micro, and medium enterprises (SMMEs) (Sohail & Cavill, 2008). Research suggests that the likelihood of SMMEs being victims of corruption increases as the economy performs poorly (Sun, Liyin & Lin, 2013). According to research, SMMEs and established firms could collaborate to sustain SMMEs and protect them from corruption (Loosemore & Lim, 2015).

2.6 Whistleblowing

Whistleblowing is one of the methods that has been used to detect corruption activities (Gottschalk & Smith, 2016). Effective whistleblowing can alleviate economic losses from undetected misconduct (Oladinrin et al., 2017). Whistleblowing can be hindered by cultural barriers, fear of retaliation, inaccurate estimations of the severity of misbehaviours, and negative management attitudes (Oladinrin et al., 2017). Unfortunately, whistleblowers experience challenges; they often do not get the legal protection they need (Apaza & Chang, 2011). To ensure whistleblowers continue to help detect corruption, they

need to be protected (Gottschalk & Smith, 2016). In some countries, a legal anti-corruption network protects and encourages whistleblowers from exposing corruption (Lingbing, 2012; Gunduz & Önder, 2013). Although whistle-blowing protection laws are gradually being introduced, the rights have often been largely symbolic and counterproductive (Chassang & Miquel, 2012).

3. Methodology

The study used a qualitative inductive research approach employing an open-ended semi-structured interview protocol in data collection.

3.1 Study sample and Sample size

The population of interest included all professionals operating within the private and public built environment sectors in Johannesburg, SA. Individuals were eligible for study participation if they belonged to a built environment professional association, specifically: Engineering Council of SA; SA Council for Project and Construction Management Professions; SA Council for Quantity Surveying Profession; Council for Landscape Architectural Profession; SA Council for Property Valuers Profession; SA for Planners; and SA Council for the Architectural Profession.

The study sample comprised 11 participants who were professionals currently operating in the built environment sector of the South African construction industry (including their clients) identified using a convenience sampling approach. The sample size was reached when the study reached saturation point. Six of the 11 participants were engineers, two were project/program managers, and a contractor, an estimator, and a quantity surveyor (see Table 1).

Table 1: Profile of the Participants

Informant	Role of participant	Qualifications	Years of Experience
R1	Cost Engineer	BTech: Quantity Surveying	11
R2	Contractor	Hons: Construction Management	15
R3	Programme Manager	BTech: Quantity Surveying	9
R4	Senior Ore Process Engineer	BSc: Chemical Engineering	9
R5	Senior Process Engineer	BSc: Mechanical Engineering	15
R6	Chemical Engineer	BTech: Chemical Engineering	17
R7	Estimator	Dip: Building Science	9
R8	Quantity Surveyor	Hons: Construction Studies	3
R9	Electrical Engineer	BTech: Eletrical Engineering	10
R10	Civil Engineer	BTech: Extraction Metallurgy	9
R11	Construction Project Manager	BTech: Architectural Management	16

3.2 Data collection

Invitations to participate in the study were sent to the population of interest. A snowball sampling technique was used to recruit participants (Noy, 2008). Respondents were asked to select or recommend other employees. Key themes from the literature review on corruption in the construction industry guided the development of the interview protocol. The protocol assessed 12 key areas: project costs and collusion; collusion and poor ethics; whistleblowing and corruption; corruption and economic growth; corruption and project outcomes; corruption and government; incompetent contractors and overall performance; incompetent contractors and corruption; corruption and sustainability of SMMEs; unethical practices and procurement; poor ethics and unethical behaviour; and procurement processes and lack of transparency. Personal interviews that took approximately 45 to 60 minutes were conducted.

3.3 Ethical consideration

An introduction letter was given to participants before the interview. The confidentiality of interviews was preserved, and informed consent was obtained before study participation. The participants were assured of their confidentiality and privacy. Participants were informed that they had the right to withdraw from the study at any time without consequences. Permission was obtained from the participants to record the interview for transcription purposes.

3.4 Analysis

The interviews were audio-recorded and then transcribed verbatim. The Atlasti software was used for analysis. The study aims, and structure of the open-ended study questions guided the analysis. The interviews were coded for emergent themes. Participatory action research (PAR) and ethnographic research approaches were used.

4. Results

4.1 Project costs and collusion

Participants were asked whether unequal project costs were characteristics of collusion. Based on the responses, seven of the respondents – R1, R2, R3, R4, R7, R9 and R10 indicated that unequal project costs are not characteristic of collusion. Participants R1 and R11 gave the following alternate explanations:

According to R1 "*I think there is a lot that one could actually consider; for instance, lack of understanding of the project, the project content and also another to have a lot of small contractors or chance-takers that are actually coming into the industry. So, because they do not understand the project, they do not understand what they need to build. So, they will sort of like come and then cause all these unequal project costs because their price is not really based on what they know*."

R11 noted that "*If I know that one is charging so much for a service and I have been making enough money, but I have been charging much less than him, chances are that without talking to him or planning with him, I will most probably adjust my prices to be very close to that of the other person, which might then be seen as collusion*."

Four respondents – R4, R6, R8 and R11 agreed that unequal project costs are characteristic of collusion.

According to R7 "*Yes, that is collusion. Yes, I agree, it is a norm in the industry that companies would price for the same job, compete for the same job, and their pricing might not necessarily be too far off each other. But consciously, these guys would turn on each other and discuss and agree what sort of rates to actually better their margins…It is collusion.*"

While R6 stated that "*If the prices have been inflated, more often than not, you will find that it is as a result of colluding. There'd be champions or what you call the captains of the companies, who have come together to discuss these things.*"

4.2 Collusion and poor ethics

Regarding collusion and poor ethics, participants were asked, whether collusion exists because of poor ethics. Ten participants agreed that collusion is driven by greed and poor ethics. According to R8 "*I would say so, and greed. Poor ethics and greed, unless poor ethics. Greed falls under poor ethics.*" Also, R7 stated that "*My answer is very simple; yes. Poor ethics is a result of collusion. Simple as that*." While R1 noted that "*Yes and no because 'poor', we are saying people are not able or do not have the capacity or the capability to do right. But in most cases, companies that enter into collusion are people that know proper ethics, they know how to do right and have got good moral principles. So, it's not to say they are poor. They just don't want to adhere to good ethics….*"
Participant R1 argues that people involved in corruption mostly have good morals and are ethical but do not want to adhere to ethics.

Although most of the participants agreed that collusion results from poor ethics, they also acknowledged that certain circumstances influence people to turn to corruption or collusion as a solution. According to R10, *"…you might find that somebody is facing foreclosure, so I am a project manager and I've got serious financial problems, at home my house is about to be repossessed. And...a contractor…says, 'if you can award this contract to me, I will give you R1 million.' You will find that the R1 million is exactly the amount that is required to pay off the bond. That is where the question of ethics comes in*."

4.3 Whistleblowing and corruption

All respondents expressed a similar view when asked, whether whistleblowing occur whenever bribery or corruption occurs. The respondents view that whistleblowing is not taking place. Central to these reasons is the fear of repercussions. R4 noted that "…*Unfortunately, the risk to a whistleblower is higher than the reward that they gain from the activity. So, there is nothing that encourages it except their conscience. And if my conscience would lead me to either losing my job or be seen as they would call it in the craft impimpi, I might as well keep quiet because the risk is just too high.*" While R6 stated that "*the answer is no…it would be nice to have whistleblowing whenever it takes place, but people fear repercussions*."

One participant – R8 expressed that whistleblowing only sometimes occurs when there is corruption because people would rather be part of it and benefit from it than whistle-blow.

The views of R8, "*No, it doesn't always happen because sometimes, somebody is aware of that corrupt act, and they want to be part of it, as opposed to exposing the people that are doing it. It becomes somewhat of a culture…in the construction industry because everybody wants to benefit...*" and R1 *"… in the construction industry 'I have not seen that there has ever been whistle-blowing and I'm not sure whether it's because it's not easy to pinpoint where that corruption takes place in that industry, or if it's just because there is a lot of these big players that are already in the market that it is not easy for the people to see what they do because they already know how to play the game*" resonate with the general perspective.

A respondent – R1 further explained that corruption is generally driven by advanced and sophisticated networks capable of destroying evidence to prevent whistleblowing:
, *"… in the construction industry 'I have not seen that there has ever been whistle-blowing and I'm not sure whether it's because it's not easy to pinpoint where that corruption takes place in that industry, or if it's just because there is a lot of these big players that are already in the market that it is not easy for the people to see what they do because they already know how to play the game*."
R1

While R7 was of the view that "… *So whistleblowing does occur, yes, but I think if you want to really combat this problem, we should protect those whistleblowers and then whistleblowing will occur more often*."

Also, participants – R7 and R11 highlighted that the system requires improvement by protecting whistleblowers against adverse consequences.

4.4 Corruption and Economic Growth

There was consensus among the 11 participants when asked, whether corruption affects the economic growth of South Africa. However, there were variations in the explanations of how corruption impacts corruption. While R7 stated that "*Yes, corruption does affect the economic growth of SA. Any public work that is out there and that is in the open tender, there is corruption, clearly there will be overpricing…And that is a cost onto the taxpayers, and that money could have been used somewhere else for economic growth…,*" R4 noted that *"…it would because I am assuming that corruption makes projects to cost more what they are worth, so instead of the money being used effectively for more, it is being used for less…*"

Also, R9 was of the view that "…*It can, because if you look at collusion as a form of corruption, prices can be unfairly inflated. Which can then limit the number of projects that can happen and knowing that every time you roll out projects, there are more economic activities*," while R1stated that "*Yes, it does, because corruption is only for certain people or certain individuals, so it does not help to spread, you know, economy. It's only a group of people that benefit, not the whole of SA…*", R6 highlighted that "The answer is yes. For example, if I look at it from an angle of an investors, investors would not ordinarily want to plough their money, where corruption thrives. Right? So, and that obviously leads to the economy being robbed of the growth opportunity that they could've had, had corruption not been there…" and R8 noted that "*Yes, it does. And my perspective is that the more the country would then have a reputation and brand of being corrupt, the less foreign investment that we would get within the country...*"

4.5 Corruption and Project Outcomes

Participants agreed that corruption leads to late completion, non-completion, non-achievement of quality standards, and building collapses. For example, R6 stated that "*Yes, we've seen it in the public sphere; for example, where tenders are given to people or companies that don't necessarily have the skills or capacity to do the jobs and I can make an example with Reconstruction and Development Programme (RDP) houses, I don't know how many times we've had cases, where houses do crack and even collapse, and even roads*," while R4 stated that "*Corruption leads to the appointment of incompetent individuals, which in my mind will lead to quality standards being compromised…*"

However, R1 argued that other contributing factors are leading to these poor project outcomes noting that "*Corruption does play a role, but we cannot solely place it on corruption. Because you get contractors that are awarded contracts, you know, fairly. However, they are not able to perform. You get contracts that are being awarded to people who cannot do the work. However, because of corruption, they are given the contracts, resulting in some of these things*."

4.6 Corruption and Government

Regarding corruption and government, the study sought to know whether corrupt practices result in government departments paying contractors late and built environment professionals' fees being unequal. For the first part of the question, the participants viewed corruption as central to late payments. R11 stated that "*Yeah, these are in fact the ripple effects of corruption. Because now if you are a contractor and you do not know the system, you will find yourself, once you have submitted your progress payment certificate, if it is a department whereby your certificate has to go through seven people. Because you do not know the system that you have to pay each and every one of them, they will just sit there with your certificate. Months will pass or six months will pass*."

According to R2, "*You see now on this one, I am going to give a yes and a no, because yes, corrupt practices do result in government paying contractors late…if you want your papers pushed forward, then you need to pay for them to be pushed forward*," while R7 noted that "*…maybe, inefficiencies and just laziness, and if you want to call them corruption, where one certificate is put from the bottom of the file to the top of the pile, for a fee, that is corrupt, but then I end up not being paid on time*."

Furthermore, while R10 was of the view that "*Certain project managers will require a bribe from contractors for you to push an invoice. Then if the contractor does not comply, then you find that the invoices stay with the project manager for 3 - 6 months as a punitive measure for not agreeing with a possible bribe*," R1 viewed that "*departments only want to use certain professionals, and therefore, they then escalate their costs, not because it's the industry rates, but because they know that they are the ones that are being procured for those services, in that specific department*."

Respondent – R1 highlighted several reasons for late payment. In some cases, negligence or the client's not providing enough information to proceed also compounds the late payment: "*there are other reasons, not necessarily corruption...They [government] do pay late because of negligence of employees, because of poor procurement processes that are not being followed properly*," (R1). Corroborating this, R9 stated that "… *another one is that, remember that when you are executing a project, there are all kinds of things, documentation…that needs to be properly done. So, what I pick up is that in most instances, you would find that contractors are paid late either because they have not included the client's VAT number on the invoice or they've just done something wrong with the invoice*."

The second part of the question concerns unequal professional fees. Participant – R9 believes that unequal professional fees are not necessarily related to corruption and gave the following alternative explanation:
"*…with professionals, you go out for tender and sometimes because they want to get in there, you will find that they offer you a discount. So, you find that consulting firms are generally the cheaper ones because they don't have a lot to take care of. You find that the guys are just one…engineers working from home, he does not have too many overheads, so he can afford to give a discount. Another guy, who is running a big consulting firm with a lot of salaries to pay, then the guy will say 'the best I can do is maybe gazette rates'...*" (R9)

However, some participants – R6 and R8 believed there was an association between unequal professional fees and corruption.
"*…Yes, corruption practices do cause the professional fees to be unequal. Because if I were to think, myself as a contractor, knowing that I'm going to be paid late, I need the job, I've told you I want the job, and I will price for the late delays, the late payment. I will put it in the price. That's resulting in my price versus the other guy's being very different, and we're of the same profession*." (R6)

Other respondents – R3 and R4 believed that manipulating professional fees is not easy because the fees are regulated by law.
"*Does that mean that South African government can actually go against the law? Because professional fees are gazetted. So, it means you must pay the professional according to what has been legislated*." (R3)

4.7 Incompetent contractors and overall performance

Respondents mostly agreed with the question, "Do incompetent contractors result in contractual problems and overall poor performance?" The respondents noted:

"*Yes, the answer is definitely yes because incompetent contractors, they lead to a lot of contractual problems and overall poor performance. I mean, simply put, if you put a guy on site that is incompetent, the one thing you are sure to get is a big headache on the side of the consultant. Because he literally has to teach this guy, pull this guy's hand to try and ensure that the project becomes successful. You are going to have time over-runs*." (R2)

"*Yes, absolutely, yes. The word incompetence summarises this whole problem. That there's no way you're going to perform, if you don't know how to perform, and that results in all negative aspects to the project*." (R7)

Participants – R1, R2, R5, R10 and R11 had other explanations for poor performance, which were not related to incompetence. According to R1, "*Some perform poorly because mainly they take on many projects and they cannot, and they think that when that pays me, then I'll be injecting into this project. You see, so that also happens, especially with...Imagine contractors, they're so hungry for work, that they take a lot of projects*."

Participant – R10 highlighted that the lack of regulation within construction can also result in contractual problems and poor performance: "*…because my experience is that it is that the construction industry is not regulated like other professional environments. This is purely just a business, it is not regulated as a profession and therefore you find people who know nothing about construction raising companies quickly and getting jobs.*" (R10)

Another respondent – R6 explained that incompetent contractors prematurely spend the funds when paid upfront, resulting in a lack of performance when there are no funds to execute the project activities: "…The answer is definitely yes. Because incompetent contractors…sometimes it does happen that they get the money upfront, and before they even start doing the work, they spend it. They spend it on this long dream car I've always wanted. Yet, I haven't even touched a single spec of work…therefore, there will be no performance of the job and then contractual problems are raised straight from there." (R6)

Another participant pointed out that the issue is not necessarily incompetence but rather the contractual terms:
.
"*in some instances, you get contractors that abandon a project, because now, cash flow is not coming in as they had forecast, because of the contractual terms that are being stipulated in contracts by departments*." (R1)

4.8 Incompetent contractors and corruption

For the eighth question, the study sought to find out from participants whether incompetent contractors cause corruption. There were diverse views among the participants as highlighted below.
"*No, corruption is not necessarily by incompetent contractors. I think it's more so the competent contractors that are prone to corrupt practices… But then on the other hand, incompetent contractors…when they've underperformed in one project, then it's difficult for them to get work in other projects. So, then they would get into a corrupt agreements with whoever is awarding the contracts*" (R1)

"*Man, I want to say no. I'm saying no because it's not the incompetent contractors, it's the appointment of incompetent contractors that causes corruption. The process starts there...*" (R7)
"*The answer is definitely yes…I would say, it's also two-way. Incompetent contractors would cause corruption…where I, as an incompetent contractor, will approach you as government department and say 'I will pay you A, B and C', but it also happens in reverse, where those who dish out the work and the ones who instigate corruption by either employing their relatives or friends, or friends of friends, who don't know the job or who, in other words, are incompetent, and therefore corruption results.*" (R6)

Respondent – R8 explained that sometimes incompetence could be due to people taking shortcuts: "*they may,*

because they want to take shortcuts...they may want to pay for inspectors as opposed to following the proper procedures that are meant to be followed." (R8)

Additionally, R11 expressed the view that political connections enable contractors, even incompetent ones, to engage in corruption stated as follows: "*not necessarily so; that again depends on whether that particular contractor has connections. Because nowadays, people are using political connections to acquire contracts or government contracts...Yes, you find contractors that are incompetent that are there, and they know deep down that they got there illicitly.*"

4.9 Corruption and sustainability of small and medium enterprises

There was consensus amongst the respondents when the study sought to know whether corruption affects the sustainability of small and medium enterprises, noting as follows:
"*I think it does…when you are a big business or large, where they are able to undercut or underquote. Because they can carry the deficit and then they end up getting business based on price, while the poor small person cannot carry the loss because they do not have financial backing and the capital. So they end up not even getting those small projects that are due to them and all the projects now go to the big business because they can run at a minimum loss for the time and carry the cost and continue. So it does affect them*." (R4)

"*Yes, I agree. This speaks to me personally because my company, I had a small enterprise, has gone down because of this. In many ways, it has indebted me because I had to go and make loans to pay suppliers, to pay labour, to pay people who were threatening me. So, it affects us in a very negative way. So yes, it kills the sustainability of any business and it kills the growth of the economy, economic growth, of SA*." (R7)

4.10 Unethical practices and procurement

The study sought to to know whether unethical practices during procurement prevent contractors from securing projects due to preferred contractors. The participants agreed that unethical practices affect contract security and some of their views are noted as follows:
"*I think it is a possibility. It could happen because you would find in some cases, there is a specification that is modelled or packaged to suit a particular contractor, so that when you do your evaluation…your preferred contractor comes out top. There is a way, where you can engage in unethical practices and ensure that a project is directed to certain contractors purely based on how you package your specifications...*" (R10)

"*Yes. Absolutely...From appointing incompetent contractors, there are underhand dealings where guys who do not deserve the job are getting the job. They are getting paid upfront. Their entire budget is approved, and there is no building or no delivery on what they need to deliver. So yes, these unethical practices do happen during the procurement*." (R7)

"*Yes is the answer. I know of a guy, for example, in one of the companies I worked for, who was found to be manipulating the procurement practice and the selection of the preferred contractor, and it was established that he was getting kickbacks for that. It was found out that he had been entrapped...*" (R6)

"*…we get to a tender stage, and then they will have a recommendation to say we would rather use so and so because we know his work, he is a performer, he is quality, and he is 100% and everything. And yet, so and so has not won the tender, has not been the first guy that can be chosen…* (R1)

4.11 Poor ethics and unethical behaviour

The study also wanted to know whether poor ethics among built environment stakeholders result in unethical behaviour. All participants believe that poor ethics in the built environment influence unethical behaviour, but only one remains unsure (R2). Some of the views buttressing this assertion:
"*Yes, because if you've got poor ethics, then your behaviour translates to your ethics and your morals. So, yes, it does, because once you start off not adhering to ethics…then that changes your behaviour… The thing is, within the built environment, it's easy to be lured to do things that you would not normally do*." (R1)

"*Yes. It becomes, It's poor ethics. If the stakeholders do not have ethics, they don't know how to actually go about business in the right way, then it promotes unethical behaviour, then it becomes a culture, because it's coming from the top, filtering down, and it becomes a culture. So, most activities that they will do will be centred on that*." (R8)

A participant partially agreed with the statement, emphasizing that the environment influences people to act contrary to their beliefs: "*the answer is yes and no...Where you find some people, who are referred to as 'people of integrity', when they can help it, they will resist acting in an unethical manner, just because of the environment they are in…To answer the yes part, yes where people are put under undue pressure to deliver something that will seem to be unethical, yes, because they want to save their jobs, they may end up doing those unethical things because of the pressure that is put on them.*" (R6)

Another participant believes that if there were forums to motivate ethical behaviour, there would not be so much corruption in the industry: "*Yeah, I think what needs to happen in… a conference, the emphasis should be on ethics...I think it is important for conferences and for voluntary associations to prioritize the issue of ethics, and again, to develop case studies. When gatherings are taking place, the issue of ethics is given the platform that it deserves*." (R11)

4.12 Procurement processes and lack of transparency

The study also sought to know whether the manipulation of procurement processes is a result of the lack of transparency. The participants seem to agree with each other on this question as expressed in the following views:

"*Yes, the answer is yes, the lack of transparency. In the local government now, they're talking about open tenders and how that process of having open tenders has eradicated a lot of this manipulation of this procurement process. So clearly, if it's not transparent or open, there is obviously room and resulting in manipulation*." (R7)

"*Yes, I agree…However, I myself, I don't have experience in procurement processes, but you hear things…it definitely does, unfortunately, it happens, so my answer is just yes*." (R5)

"*Yeah I think it happens. Because people would tend to do unethical things because they know, or they think, they won't be caught. So, these things are done mostly not in the open. But then, if that cloud of secrecy can be lifted and people know that all eyes are on me, then they will shy away from manipulating processes, which are in place to guide exactly against corrupt practices*." (R6)

The thematic analysis reveals the complex interplay of corruption, collusion and ethics in the South African construction industry, highlighting systemic issues that hinder transparent practices and and undermine economic growth and ethical conduct. Each theme not only illustrates perceptions held by participants but also suggests areas where intervention may be needed to improve the transparency of transactions in the construction industry.

5. Discussion of Findings

In this study, the researchers examined the practitioners' understanding of corruption within the South African construction industry. The researchers found that participants mostly disagreed when asked if unequal project costs are characteristic of collusion. Those who disagreed explained that a lack of understanding and knowledge surrounding project management and comparing prices to other contractors could lead to prices being inflated. While those who agree state that price inflation is typically a consequence of collusion. A report on corruption found that contractors inflate project prices to recover the funds spent on bribes, resulting in exaggerated costs (OECD, 2016).

The researchers found that most respondents agreed that collusion exists because of poor ethics. Similarly, a study conducted among construction professionals in SA found that respondents ranked poor ethics as the second-most common factor causing collusion (Oke *et al*., 2017). There was consensus among the participants that whistleblowing does not take place whenever corruption occurs. Participants further explained that whistleblowing does not occur mainly due to fear of the repercussions. Existing literature supports that whistleblowing is a risk resulting in harassment and death (Chassang, 2012), which explains why whistleblowing is thought not to take place. Moreover, respondents agreed that corruption affects the economic growth of SA. Previous literature supports that corruption impacts economic growth by impeding investment (Chêne & MarTransparency International, 2014). Investors might be less likely to invest in a corrupt and unstable economy. Additionally, the literature supports that corruption negatively affects the economy because it reduces service delivery and misrepresents the allocation of resources (Shera *et al*., 2014).

Participants felt corruption leads to late completion, non-completion, non-achievement of quality standards, and building collapses. Similarly, a previous study found that corruption was associated with building collapses and using sub-standard materials (Agwu, 2014). Earlier research supports that corruption is often the root cause of project non-completion and poor workmanship due to the hiring of contractors who are unqualified or inexperienced (Oyewobi *et al*., 2011). Regarding corruption and government, respondents agreed that corrupt practices result in government departments paying contractors late and in a built environment, professionals' fees being unequal. Research shows that government officials embrace the slow payment culture because they tend to expect a bribe as an incentive to speed up the process (Méon & Weill, 2010).

Moreover, respondents mostly agreed that incompetent contractors result in contractual problems and overall poor performance. Research elaborates that the issue with poor performance is that, at times, it costs more than expected because work must be redone (De Morais, 2010; Ngomi, 2017). A study examining the influences of performance on construction projects found that project sites are often poorly managed when contractors are incompetent and lack experience (Ngomi, 2017). In addition, a prior study found consensus among participants that incompetent contractors tend to produce shoddy work (Soni & Smallwood, 2023).

Participants had differing views regarding incompetent contractors being the cause of corruption. Those who disagreed with the statement argued that competent contractors are also likely to engage in corrupt practices and that the appointment of incompetent contractors causes corruption. On the other hand, those who agreed argued that incompetent contractors are willing to pay fees/bribes to get the job. Earliers research supports the finding that incompetent contractors tend to be appointed through corrupt practices, even by government officials (van Klinken & Aspinall, 2011). Although the literature reveals that incompetent contractors engage in corruption (van Klinken & Aspinall, 2011), it does not support the view that incompetent contractors cause corruption.

Regarding corruption and the sustainability of SMMEs, there was consensus among respondents. Previous research states that SMMEs are likely to be vulnerable when the economy performs poorly (Sun, Liyin & Lin, 2013). The economy is known to have an inverse

relationship to corruption; when corruption increases, the economy is likely to decrease (Bai & Jayachandran, 2013). Thus, there is a risk of SMMEs in construction being affected by corruption (Sohail & Cavill, 2008). Additionally, there was consensus among participants that unethical practices affect securing contracts during procurement, arguing that these processes can be manipulated. Research shows that during the tender process, unethical practices occur, and government officials interfere with procurement processes (Mizoguchi & Van Quyen, 2014). Therefore, such unethical practices can affect the securing of projects.

Moreover, all respondents believe poor ethics among stakeholders in the built environment result in unethical behaviour. Participants argued that once an individual has poor ethics, it can translate into behaviour, meaning poor ethics make it easier to be lured into an unethical act. Although previous studies have shown unethical practices exist in the built environment (Boahene & Nani, 2015; Sichombo *et al*., 2009), studies have not shown that unethical behaviour stems from poor ethics. Furthermore, participants agree that the manipulation of procurement processes results from a lack of transparency. Similarly, a study using data from firms found fewer kickbacks when the procurement information was made public (Knack *et al*., 2019). Further, literature suggests procurement processes tend to be affected by corruption even when policies are implemented to create a transparent process (Gottschalk & Smith, 2016).

6. Conclusion

The study explored construction practitioners' understanding of corruption in the industry. Findings highlight that collusion is associated with poor ethics and that unethical behaviour is intertwined. Research findings illustrate that corruption in the construction industry adversely affects the country's economic growth, the presence of SMMEs, quality standards of projects, payments of contracts, and procurement processes, as well as preventing whistleblowing. Corruption is still prominent in the South African construction industry, even in government departments. Given the adverse relationship between corruption and economic growth, corruption must be eliminated to support economic growth in SA. Eradicating corruption in construction will also improve service delivery and the quality standards of structural infrastructure. Approaches to eradicate corruption in construction need to be strengthened.

The researchers acknowledge the study sample size as a limitation; however, literature has shown that qualitative studies can reach saturation even with relatively small sample sizes (Guest, Bunce & Johnson, 2006; Hennink & Kaiser, 2022). The researchers acknowledge that the research was conducted in SA, so the findings might not apply to populations outside South Africa. However, the researchers used a comprehensive selection criterion by including practitioners in the public and private sectors involved in the seven associations in Johannesburg, SA. Further studies are needed to explore research that could shed light on corruption in construction.

References

Abdul-Rahman, H., Hanid, M., & Yap, X. W. (2014). Does professional ethics affect the quality of construction? A case in a developing economy. *Total Quality Management & Business Excellence*, 25(3-4), 235–248. https://doi.org/10.1080/14783363.2013.776764

Abdul-Rahman, H., Kho, M., & Wang, C. (2014). Late payment and nonpayment encountered by contracting firms in a fast-developing economy. *Journal of Professional Issues in Engineering Education and Practice*, 140(2), 04013013. https://doi.org/10.1061/(ASCE)EI.1943-5541.0000189

Agwu, M. O. (2014). Perception survey of poor construction supervision and building failures in six major cities in Nigeria. *British Journal of Education, Society & Behavioural Science*, 4, 456–472.

Ali, A., & Kamaruzzaman, S. N. (2010). Cost performance for building construction projects in Klang Valley. *J. Build. Perform.*, 1.

Ali, A. S., Smith, A., Pitt, M., & Choon, C. H. (2010). Contractors' perception of factors contributing to project delay: Case studies of commercial projects in Klang Valley, Malaysia. *Journal of Design and Built Environment*, 7(1).

Alon, I., Li, S., & Wu, J. (2016). Corruption, regime type, and economic growth. *Public Finance and Management*, 16, 332–361.

Ameyaw, C., Mensah, S., & Osei-Tutu, E. (2012). Public procurement in Ghana: The implementation challenges to the Public Procurement Law 2003 (Act 663). *International Journal of Public Sector Management*, 2, 55–65.

Ángel, A. (2016). La construcción retórica de la corrupción/Rhetorical construction of corruption/Construcao retorica da corrupcao. *Chasqui. Revista Latinoamericana de Comunicación*, (132), 307–327.

Apaza, C. R., & Chang, Y. (2011). What makes whistleblowing effective? *Public Integrity*, 13(2), 113–130. https://doi.org/10.2753/PIN1099-9922130202

Asamoah, R., & Decardi-Nelson, I. (2014). Promoting trust and confidence in the construction industry in Ghana through the development and enforcement of ethics. *September 8*.

Ateljevic, J., & Budak, J. (2010). Corruption and public procurement: An example from Croatia. *Journal of Balkan and Near Eastern Studies*, 12, 375–397. https://doi.org/10.1080/19448953.2010.531202

Bai, J., Jayachandran, S., Malesky, E. J., & Olken, B. (2013). Does economic growth reduce corruption? Theory and evidence from Vietnam. (NBER Working

Papers 19483). National Bureau of Economic Research, Inc. Available at: https://EconPapers.repec.org/RePEc:nbr:nberwo:19483

Baloyi, L., & Bekker, M. C. (2011). Causes of construction cost and time overruns: The 2010 FIFA World Cup stadia in South Africa. *Acta Structilia*, 18.

Basheka, B. C., & Bisangabasaija, E. (2010). Determinants of unethical public procurement in local government systems of Uganda: A case study. *International Journal of Procurement Management*, 3(1), 91–104.

Boahene, B. A., & Nani, G. (2015). Redefining corrupt public procurement practices in Ghana based on stakeholders' perception. *1–23*.

Bowen, P., Akintoye, A., Pearl, R., & Edwards, P. J. (2007). Ethical behaviour in the South African construction industry. *Construction Management and Economics*, 25(6), 631–648. https://doi.org/10.1080/01446190701225707

Bowen, P. A., Edwards, P. J., & Cattell, K. (2012). Corruption in the South African construction industry: A thematic analysis of verbatim comments from survey participants. *Construction Management and Economics*, 30(10), 885–901. https://doi.org/10.1080/01446193.2012.711909

Buys, F., & Le Roux, M. (2014). Causes of defects in the South African housing construction industry: Perceptions of built-environment stakeholders. *Acta Structilia*, 20(2), 78–99.

Chassang, S., & Miquel, G. P. (2012).

Enshassi, A., Al-Najjar, J., & Kumaraswamy, M. (2009). Delays and cost overruns in construction projects in the Gaza Strip. *Journal of Financial Management of Property and Construction*.

Fugar, F. D., & Agyakwah-Baah, A. B. (2010). Delays in building construction projects in Ghana. *Australasian Journal of Construction Economics and Building*, 10(1/2), 128–141.

Gebrehiwet, T., & Luo, H. (2017). Analysis of delay impact on construction projects based on RII and correlation coefficient: Empirical study. *Procedia Engineering*, 196, 366–374.

Goldie-Scott, H. (2008). Briefing: Corruption in construction in developing countries. In *Proceedings of the Institution of Civil Engineers-Municipal Engineer* (Vol. 161, pp. 211–213). Thomas Telford Ltd.

Gottschalk, P., & Smith, C. (2016). Detection of white-collar corruption in public procurement in Norway: The role of whistleblowers. *International Journal of Procurement Management*, 9(4), 427–443.

Grabova, P. (2014). Corruption impact on economic growth: An empirical analysis. *Journal of Economic Development, Management, IT, Finance, and Marketing*, 6(2), 57.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods*, 18(1), 59–82. https://doi.org/10.1177/1525822X05279903

Gunduz, M., & Önder, O. (2013). Corruption and internal fraud in the Turkish construction industry. *Science and Engineering Ethics*, 19(2), 505–528.

Habtemichael, F., & Cloete, F. (2010). Complexity thinking in the fight against corruption: Some perspectives from South Africa. *Politikon*, 37(1), 85–105.

Heidenheimer, A. J., & Johnston, M. (2011). *Political corruption: Concepts and contexts* (Vol. 1). Transaction Publishers.

Hennink, M., & Kaiser, B. N. (2022). Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Social Science & Medicine*, 292, 114523. https://doi.org/10.1016/j.socscimed.2021.114523

Ibem, E. O., & Laryea, S. (2017). E-tendering in the South African construction industry. *International Journal of Construction Management*, 17(4), 310–328.

Iyanda, D. O. (2012). Corruption: Definitions, theories, and concepts. *Oman Chapter of Arabian Journal of Business and Management Review*, 2(4), 37–45. Sohar University. Available at: https://books.google.co.za/books?id=IeatnQAACAAJ

Jong, M. D., Henry, P. W., & Stansbury, N. (2009). Eliminating corruption in our engineering/construction industry. *Leadership and Management in Engineering*, 9(3), 105–111. https://doi.org/10.1061/(ASCE)1532-6748(2009)9:3(105)

Kenny, C. (2009). Transport construction, corruption, and developing countries. *Transport Reviews*, 29(1), 21–41.

Kim, S.-Y., Van Tuan, N., Ogunlana, S. O., & others. (2009). Quantifying schedule risk in construction projects using Bayesian belief networks. *International Journal of Project Management*, 27(1), 39–50.

van Klinken, G., & Aspinall, E. (2011). Building relations: Corruption, competition, and cooperation in the construction industry. In *The state and illegality in Indonesia* (E. Aspinall & G. van Klinken, Eds., pp. 139–163). KITLV Press.

Knack, S., Biletska, N., & Kacker, K. (2019). Deterring kickbacks and encouraging entry in public procurement markets: Evidence from firm surveys in 90 developing countries. *The World Bank Economic Review*, 33(2), 287–309.

Kuta, E. J. N. (2021). Influence of poor regulation and supervision mechanisms on construction of substandard buildings in Kenya. *Asian Journal of Computing and Engineering Technology*, 1(1), 19–26.

Lambsdorff, J. G. (2008). Transparency International 2008 corruption perception index. In *Global Corruption Report* (Transparency International, Berlin, pp. 232–236).

Laryea, S. A. (2010). Challenges and opportunities facing contractors in Ghana.

Le, Y., Shan, M., Chan, A. P., & Hu, Y. (2014). Overview of corruption research in construction. *Journal of Management in Engineering*, 30(4), 02514001.

Lewis, J. (2011). Corruption: The hidden perpetrator of underdevelopment and vulnerability to natural hazards and disasters: The Pat Reid lecture 2010. *Jàmbá: Journal of Disaster Risk Studies*, 3(2), 464–475.

Lewis-Faupel, S., Neggers, Y., Olken, B. A., & Pande, R. (2016). Can electronic procurement improve infrastructure provision? Evidence from public works in India and Indonesia. *American Economic Journal: Economic Policy*, 8(3), 258–283. https://doi.org/10.1257/pol.20140258

Lingbing, K. (2012). The network anti-corruption under the perspective of the rule of law. *Public Administration & Law*.

Links, F., & Haimbodi, M. (2011). *Building integrity: Corruption and the construction industry*. Institute for Public Policy Research.

Loosemore, M., & Lim, B. (2015). Inter-organizational unfairness in the construction industry. *Construction Management and Economics*, 33(4), 310–326.

Matheson, V. A., Schwab, D., & Koval, P. (2018). Corruption in the bidding, construction, and organization of mega-events: An analysis of the Olympics and World Cup. In *The Palgrave Handbook on the Economics of Manipulation in Sport* (pp. 257–278). Springer.

Méon, P.-G., & Weill, L. (2010). Is corruption an efficient grease? *World Development*, 38(3), 244–259.

Mizoguchi, T., & Van Quyen, N. (2014). Corruption in the public procurement market. *Pacific Economic Review*, 19(5), 577–591.

de Morais, R. M. (2010). The new imperialism: China in Angola. *World Affairs*, 173, 67.

Muhwezi, L., Acai, J., & Otim, G. (2014). An assessment of the factors causing delays on building construction projects in Uganda. *International Journal of Construction Engineering and Management*, 3(1), 13–23.

Ngomi, A. (2017). Factors affecting project performance among local contractors. *The International Journal of Multi-Disciplinary Research* ISSN, 1–51.

Nguyen, T. P., & Chileshe, N. (2015). Revisiting the construction project failure factors in Vietnam. *Built Environment Project and Asset Management*.

Nguyen, T. T., & Van Dijk, M. A. (2012). Corruption, growth, and governance: Private vs. state-owned firms in Vietnam. *Journal of Banking & Finance*, 36(11), 2935–2948.

Niazi, G. A., & Painting, N. (2017). Significant factors causing cost overruns in the construction industry in Afghanistan. *Procedia Engineering*, 182, 510–517.

Noy, C. (2008). Sampling knowledge: The hermeneutics of snowball sampling in qualitative research. *International Journal of Social Research Methodology*, 11(4), 327–344.

Ogunde, A., Olaolu, O., Afolabi, A., Owolabi, J., & Ojelabi, R. A. (2017). Challenges confronting construction project management systems for sustainable construction in developing countries: Professionals' perspectives (a case study of Nigeria). *Journal of Building Performance*, 8(1), 1–11.

Oladinrin, O. T., Ho, C. M., & Lin, X. (2017). Critical analysis of whistleblowing in construction organizations: Findings from Hong Kong. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 9(2), 04516012.

Olken, B. A. (2007). Monitoring corruption: Evidence from a field experiment in Indonesia. *Journal of Political Economy*, 115(2), 200–249.

Olusola, K., Ojambati, T., & Lawal, A. (2011). Technological and non-technological factors responsible for the occurrence of collapsed buildings in South-Western Nigeria. *Journal of Emerging Trends in Engineering and Applied Sciences*, 2(3), 462–469.

Palguta, J., & Pertold, F. (2014). Corruption and manipulation of public procurement: Evidence from the introduction of discretionary thresholds. Prague: CERGE-EI.

Park, Y.-I., & Papadopoulou, T. C. (2012). Causes of cost overruns in transport infrastructure projects in Asia: Their significance and relationship with project size. *Built Environment Project and Asset Management*.

Shan, M., Chan, A. P., Le, Y., Hu, Y., & Xia, B. (2017). Understanding collusive practices in Chinese construction projects. *Journal of Professional Issues in Engineering Education and Practice*, 143(3), 05016012.

Shokri-Ghasabeh, M., & Chileshe, N. (2016). Critical factors influencing the bid/no-bid decision in the Australian construction industry. *Construction Innovation*.

Sohail, M., & Cavill, S. (2008). Accountability to prevent corruption in construction projects. *Journal of Construction Engineering and Management*, 134(9), 729–738.

Sun, C., Liyin, S., & Lin, G. (2013). An analysis on competitiveness enhancement by applying e-commerce to construction corporations. *International Journal of Digital Content Technology and its Applications*, 7, 772–780. https://doi.org/10.4156/jdcta.vol7.issue8.88

Swaleheen, M. (2011). Economic growth with endogenous corruption: An empirical study. *Public Choice*, 146(1), 23–41.

Tabish, S., & Jha, K. N. (2012). The impact of anti-corruption strategies on corruption-free performance in public construction projects. *Construction Management and Economics*, 30(1), 21–35.

de Vaal, A., & Ebben, W. (2011). Institutions and the relation between corruption and economic growth. *Review of Development Economics*, 15(1), 108–123. https://doi.org/10.1111/j.1467-9361.2010.00596.x

Zunguzane, N., Smallwood, J., & Emuze, F. (2012). Perceptions of the quality of low-income houses in South Africa: Defects and their cause. *Acta Structilia: Journal for the Physical and Development Sciences*, 19(1), 19–38.

JCBM (2024) 7(5) 57-71

University of Cape Town

Journal of Construction Business and Management

http://journals.uct.ac.za/index.php/jcbm

Addressing the Housing Shortage Gap in Nigeria: An Exploration of the Dry Construction Method.

[1]Adeolu Oyesola Oyebode and [2]Emmanuel Itodo Daniel

[1&2] University of Wolverhampton, United Kingdom

Received 30 November 2023; received in revised form 14 February 2024; 23 May 2024; 03 August 2024; accepted 16 August 2024
https://doi.org/10.15641/jcbm.7.1.1487

Abstract

Due to Nigeria's housing shortage, which has been increasing since the late 20th century and currently stands at 20 million units with a loss rate of 780,000 units annually, Nigeria's construction industry has been under pressure to adopt a modern, timely, and premium construction strategy. This research aims to assess how the dry construction method affects mass housing delivery in developing countries, focusing on Nigeria. This study employed a qualitative research approach, conducting semi-structured interviews with sixteen experts and specialists in dry construction and housing who work for various organisations in Nigeria.The study concluded that, although dry construction is infrequently used in developing countries, it offers significant potential for emerging economies and mortgage companies to ensure prompt housing delivery. By reducing building time and improving housing accessibility, dry construction can address the current challenges of delivering affordable housing in Nigeria. To successfully implement the dry construction method in closing the housing deficit in Nigeria, the research also noted that the government must change its priority beyond direct house development towards creating a conducive framework for the industry. This study presents key stakeholders in the housing sector with the information they need to adopt and implement the dry construction method to close the housing gap, especially in Nigeria, which has received less attention.

Keywords: Affordable Housing, Dry Construction Method, Housing Accessibility, Mass Housing Delivery, Qualitative Research

1. Introduction

Housing is human habitation and may be considered an indispensable necessity for man (Olotuah & Aiyetan, 2006). It significantly contributes to man's economic, social, and psychological life. On the other hand, despite the great significance and value of housing to humanity, its accessibility in terms of cost and availability in developing countries is unreal (Anthony *et al.*, 2017), thereby making the administration of housing a major fuss in the developing countries (Olotuah & Aiyetan, 2006). Like other developing countries, housing provision in Nigeria has been declining towards the end of the 20th century and has even worsened in the 21st century (Taiwo & Adeboye, 2013). Aule & Jusan (2019) established that housing provision in Nigeria is at a 20 million unit shortage and an annual decline rate of an additional 780,000 units.

Despite efforts from both the government and the private sector to increase the housing provision in Nigeria, the annual one million housing target remains a hallucination (Aule & Jusan, 2019). This could be due to the limited resources channelled toward the housing provision. The housing provision does not reflect the huge allotment of funds to housing in the National Development Plans (Olotuah & Aiyetan, 2006). Jiboye (2011), Anthony *et al.* (2017), and Olotuah and Aiyetan (2006) opined that the tremendous increase in population and high rate of migration to urban cities contributes to the deficit of housing units in developing countries such as Nigeria. In addition, despite the surge in the population increase, the housing provision in developing countries is not comparable to that of the population increase, and this has rendered many homeless, increasing poverty levels and hardship (Kalu *et al.*, 2014).

In 1991, Nigeria's National Housing Policy estimated that housing shortages in combined remote and urban regions were 8 (eight) million homes, while the deficit in 2012 was estimated to be 17 million homes (Ezeigwe, 2015). The data that Aule *et al*. (2018), The World Bank (2018), and Aule and Jusan (2019) used as a foundation forecast that,

[1] Corresponding Author
Email address: a.o.oyebode@wlv.ac.uk

as a result of Nigeria's pessimistic increase rate of housing deficit, the country's housing shortage might be more than 20 million homes by the end of 2019. To adequately address Nigeria's growing housing crisis, a government body called the Federal Housing Authority was founded in 1973 and charged with developing and carrying out a Federal Housing Development program for the nation (Aule & Jusan, 2019). But since the creation of the organisation over four decades ago, barely 37,000 homes have been constructed nationwide, a depressing rate of about 1,000 homes annually (Aule *et al*., 2018). Another initiative was made in 2012 when a housing strategy was created to provide affordable housing for low-income consumers in Nigeria; however, the gap in affordable homes remains large and continues to widen (Adegboye, 2015).

The traditional construction approach is the commonly utilised method of construction in Nigeria. It has historically been the sole option accessible to the majority of users within the construction sector (Osuizugbo, 2018). Explicitly, the traditional construction approach refers to buildings constructed of concrete block or brick masonry, which are used to create the exterior and interior of structures (Nazir *et al*., 2020). Osuizugbo (2018) asserts that the selection of the construction method has an impact on the project implementation, project duration, budget, reliability, and stability, which are the primary goals of every construction process. However, according to Nazir *et al*. (2020), despite the widespread use of this method, the literature has identified numerous issues with the conventional approach, including (I) the construction process takes longer, it impacts climate because it usually takes at least 20 weeks or longer to build with brick, and it is affected by weather (Brigden, 2013; Fewins, 2019). (II) the formation of dampness when soil or precipitation from falling ice or rain infiltrates brickwork (Brick, 2019). (III) Excessive construction expenses, as using bricks is typically regarded as being somewhat lavish due to the requirement for additional construction components.

According to Schmuecker (2011) and Bell *et al*. (2010), without considerable advancements in construction methods, conventional traditional building techniques are inadequate to meet the volume, efficiency, and durability requirements expected of the present market. Furthermore, existing performance evaluation models for buildings do not adequately account for conventional structures, which is a serious challenge considering the predominance of simulation throughout the professions that govern construction processes (STBA, 2012). To appropriately manage the shortfall in housing provision in developing countries, Andalib and Gharaati (2012) suggest the evolvement and appraisal of a new method of construction that is faster and cheaper than the conventional one. The managing director of Nigerite reported that the Nigerian construction industry has the responsibility of initiating a new method of construction that is efficient with less financial implication, especially when considering that Nigeria's capital expense was 24 per cent of the operating cost in 2014 (Adegboye, 2015). The Dry Construction Method (DCM) was proposed as a positive and cognitive way of achieving industrialised housing provision in developing countries (Andalib & Gharaati, 2012). Obinna-Esiowu (2018) reported that dry construction is a cost-effective and technology-efficient method suitable for accelerating housing provision in Nigeria.

The construction technology involves the implementation of prefabricated building parts and manufactured items, as opposed to unprocessed materials, which are known to be constructed in situ (Andalib & Gharaati, 2012). Dry construction is the non-use of mortar, dust concrete and unprocessed bricks, using recycled tiles derived from cellulose and composite materials derived from recycled tetra packs. In other words, dry construction specifically utilises prefabricated or precast materials (Ashiru & Anifowose, 2020). Furthermore, according to Adegboye (2015), the method is a more universal and speedy construction process, with the ability to save about 70% of construction time, especially when viewed in contrast with the wet (traditional) method of construction, Despite experts advocating for the Nigerian construction industry to adopt the Dry method of construction as a solution to the shortage of housing provision, the implementation of the dry construction method in housing provision is currently progressing slowly (ObinnaEsiowa, 2018). Ashiru and Anifowose (2020) assert that dry construction is the ideal viable method to close Nigeria's housing supply and demand deficit.

However, aside from the research conducted by Ashiru and Anifowose (2020) on the application of DCM in delivering low-cost housing in Nigeria, there has been limited to no research on the adoption of DCM. Although Ashiru and Anifowose (2020) conducted a study on DCM, the study was confined to case studies and a survey conducted in Kaduna, Northern Nigeria, which may not be a representative and holistic picture of the adoption of DCM in Nigeria. Furthermore, the research did not explore the approach, challenges, and success factors that could contribute to the adoption of DCM in Nigeria; instead, it focused on low-cost housing provision. Therefore, this research strives to bridge the aforementioned gaps through a series of interviews conducted with professionals practising across the country's six geopolitical zones by investigating the approach, difficulties, challenges, and success factors to the implementation and adoption of DCM in addressing housing shortages, as well as understanding the impact of DCM adoption on the work output of traditional builders and skilled artisans. The study aims to achieve these objectives by answering the following research questions:

- RQ1: What are the factors that contribute to housing provision in Nigeria?
- RQ2: How is the Dry construction method currently implemented in Nigeria?
- RQ3: How does the DCM impact traditional builders and artisans work output?
- RQ4: What is the barrier to the adoption of DCM in Nigeria?
- RQ5: What are the success factors for implementing DCM in housing construction?

2. Literature Review

2.1 Overview of Housing Shortage

The emergence of human society and economic and political systems is intimately linked to the history of habitation (Encarta, 2007). Anthony *et al.* (2017) assert that housing has a distinctive impact on people's financial, societal, political, and emotional lives because it is the single most considerable household expenditure and a significant factor in developing thriving communities. However, in most emerging countries, the housing challenge has historically been a worry of both citizens and the government, and it is nonetheless limited to the amount but also the subpar standard of existing residential properties (Ademiluyi & Raji, 2008).

Housing is among the biggest problems that emerging nations endure (Olotuah & Aiyetan, 2006; Kalu *et al*., 2014), which has led several academics to criticise public dwelling initiatives for failing to offer target populations high-quality, cheap, and appropriate housing units (Mukhija, 2004). According to Kalu *et al*. (2014), Nigeria has had a severe scarcity of liveable residences over the last three decades due to remarkable population growth, particularly among city inhabitants, without a commensurate expansion in residential facilities. Nigeria's population has increased steadily since independence in 1960. Estimates from 1963 place the country's populace at 55 million, but subsequent estimates have it at 89 million in 1991, 140 million in 2006 (NPC, 2010), 162 million in 2011 (World Bank, 2010), and 190.89 million in 2017 (Aule & Jusan, 2019). However, only 10% of Nigerians who want homes can buy or build them themselves (Kalu *et al*., 2014). This is an abysmal percentage compared to the 72% of Americans, 78.6% of Britons, 60.4% of Chinese, 54.6% of Koreans, and 92.6% of Singaporeans who could afford to buy or build homes (Ayedun & Oluwatobi, 2011).

Olusola (2014), Olotuah and Ajenifujah (2013) also note that the issue of housing provision includes urbanised migration, the rising expenditure of building project composites, an unfriendly regulation and enforceable conditions that affect housing projects, subpar mortgage market structures, a lack of skilled labour, a lack of quality in construction methods, and an excessive dependence on cement. According to the Federal Ministry of Works and Housing, Nigeria's housing demands, including the urban and remote regions, were estimated to be around eight million homes in 2000 and between twelve and fourteen million units in 2007 (Iwuagwu & Iwuagwu, 2015). This eventually came to be projected as a 17million unit shortfall by the Nigeria Bureau of Statistics and the Ministry of Housing, Lands, and Urban Development in 2012 (Ezeigwe, 2015; Iwuagwu & Iwuagwu, 2015). However, Aule and Jusan (2019) established that the current housing need in Nigeria is 20 million, with an annual decline rate of an additional 780,000 units.

2.2 Current Housing Delivery Mitigating Measures

According to Daniel *et al.* (2023) and Ubale *et al*. (2013), providing appropriate shelter for everyone involves efforts from all spheres of society, such as the corporate industry, non-governmental organisations, communities, relevant councils, associate organisations, and global community institutions. Olotuah and Aiyetan (2006) assert that the government sector has only partially participated in Nigeria's home delivery, notwithstanding the significant financial investments made in the housing industry in the National Development Plans. As a result, more is needed to fulfil predetermined benchmarks for residential development.

The Orthodox strategy, as described by Ijeoma *et al*. (2014), was one of many strategies used in the past to attempt to address Nigeria's housing issues. It is a plan in which the government embraced a variety of initiatives to tackle the country's dwelling difficulties and embraced the supply of housing for the general population as one of its social obligations (Anyanwu, 1997). According to Kalu *et al*. (2014), this initiative includes pro-socialist or command (which entails direct government involvement in the subsector during the building of rental homes at discounted prices) and a pro-market approach (encompassed raising cement and other building materials manufacturing to lower the cost of housing supplies and broadening finance facilities to support private house construction). The National Low-Cost Housing Scheme (NLCHS), introduced in 1980, was another strategy in which the government built affordable homes to sell to lower-income earners as quickly as they were finished (Ijeoma *et al*., 2014).

2.3 Dry Construction Bridging the Housing Gap

According to Knauf (2011), building walls have traditionally been made mostly of concrete blocks, which are proven and true resources that have been around for five thousand years. However, today's expectations for extremely energy-saving constructions are making concrete block construction increasingly problematic, with building walls often requiring to be nearly 50 cm wide to achieve tight regulatory criteria (Knauf, 2011). Dry construction, on the other hand, refers to building technologies that employ minimal mortar or plaster to connect lightweight structural elements in terms of meeting design and building requirements (Andalib & Gharaati, 2012). Part of the method's processing is factory-based, according to Tichelmann and Pfau (2007), such as that of manufacturing panels and structural components, which are subsequently transported to the building site with special equipment, connections and miscellaneous items of installation. Owing to the reduced mass of the DCM, Macieira and Mendonça (2016) opined that energy-absorption materials could be built more affordably than they could be in a brick and concrete fitting-out design.

Halirova *et al*. (2017) and Andalib and Gharaati (2012), note that in DCM, the use of unprocessed materials is substituted by the use of construction goods, which implies that the use of gypsum and cellulose fibres combined application, and timber is more prevalent than it is with gypsum mortar, cement granules, or bricks. Likewise, cold-rolled metal and timber profiles are far more frequent

than brick load-bearing structures or hefty metal and masonry frameworks (Andalib & Gharaati, 2012). Kalsi Board, which is manufactured from cement, organic limestone, viscose, quarry dust, and water and then autoclaved at elevated heat and compression for structural strength and rigidity, is another proven material used for this procedure, mainly in Nigeria (Okeke, 2019). The research conducted by Arab *et al*. (2021) suggests that DCM has expanded dramatically in recent years due to its potential to reduce fossil fuel consumption, power consumption, and emissions from power utilisation in structures. Even if this technique is deemed inadequate for accomplishing the goal of industrialisation, it can perform as an infrastructural initiative in emerging nations (Andalib & Gharaati, 2012).

Besides the benefits, such as lightweight and faster construction, the benefits of this approach have now been examined in sustainable construction more often than before. According to Ashiru and Anifowose (2020), the technique offers government and Primary Mortgage Institutions the potential to provide low-cost dwellings quickly by reducing construction duration by 70 per cent and allowing Nigerians to purchase a home more quickly. Even though the concept of lightweight construction using dry components is indeed not uncommon, the practical implementation of the technique as a strategy for effective delivery of residential buildings is a little-known truth in many emerging regions which could be taken seriously and improved in the future (Andalib & Gharaati, 2012).

The potential of dry construction compared to traditional wet construction in terms of time was analysed in a simulation study by Kozlovska *et al*. (2023), and it was found that utilising only the dry construction method can reduce the construction period by 40% to 80% of the amount of time required for wet or traditional methods. Following World War II, the US government investigated several assembled construction techniques, with dry manufactured housing becoming a significant player that currently accounts for about 20% of the housing market in the United States and is second in terms of supply of housing units which eventually became a crucial strategy to meet the country's growing housing demand (Jaillon & Poon, 2009; Jeong *et al*., 2006). The Singaporean government also implemented similar measures in the early 1980s to promote the use of the prefabrication system (DCM) to boost housing development (Tam *et al*., 2002). DCM was extensively utilised in the construction of public housing, accounting for 84% of Singaporeans living in such housing in 2011 and 95% being the owners of such homes (Lye, 2020).

As such, professionals in the building business agreed that dry construction is the better alternative for bridging the demand gap in Nigerian housing delivery (Ashiru & Anifowose, 2020). David and Emmanuel (2018) opined that the key difficulties of housing projects in Nigeria, particularly low-cost home construction, as argued by researchers and stakeholders, are construction cost, tight schedule, and work delivery quality. Adegboye (2015) proposes that the construction sector should enable an increase in skill acquisition and constant training to ensure that innovation survives in Nigeria. Okeke (2019) and Adegboye (2013) reported that dry construction methods could help Nigerians meet their housing needs if the right conditions were in place.

3. Research Method

3.1 Approach

Qualitative research was adopted, considering it depends heavily on the respondents to answer in-depth queries regarding how they have developed or comprehended their expertise in DCM (Jackson *et al*., 2007). Crescentini and Mainardi (2009) asserted that qualitative studies and methodologies are becoming increasingly popular in the social sciences. This trend may be attributed to the fact that qualitative studies focus on analysing people's experiences from a holistic and interpretive perspective (Jackson *et al*., 2007); because this is an exploratory study, an interpretive research approach was employed, which relied on interviewing and analysing the responses of the selected participants to find or generate a rich and deep understanding of DCM.

For the purpose of this study, the DCM's application requires that respondents be professionals in the fields of housing development, construction, and building environment. The approach utilised is in accordance with the Center for Social Research, a non-probability technique that encompasses purposive sampling amongst various sampling techniques (Torchim, 2022). Oliver (2006) described non-probability sampling as a method whereby the scholar chooses which people to engage in the group depending on a range of factors, such as the person's competence and desire to engage in the study and their technical expertise. As a result, the interviewees were chosen based on their competence in dry construction technology, housing construction, and project management. Another factor examined in selecting candidates is the location of projects completed to guarantee a representative sample from each of the country's six geopolitical zones.

3.2 Data Instrument

The versatility and possibility for open and in-depth conversation with the respondents made the semi-structured interviews suitable (Bailey, 2007), and, as a result, they were adopted for this research. Semi-structured interviews were conducted with identified housing experts, project managers, designers, construction company experts, contractors, and other professional workers who were chosen through a non-probability sampling. Moreover, Gelling's (2016) recommendation that all studies involving human respondents, whether actively or passively, necessitate those conducting the study to consider the ethical significance of their study. Therefore, ethical approval for this research was obtained from the University of Wolverhampton, and a consent form was sent to the chosen participant before collecting data. This study was successful due to the willingness of the participants to participate in the interview.

3.3 Conducting Interviews

To enhance the research's purpose and scope, 25 participants were approached from across the country's six geopolitical zones, with expertise in dry construction technology, housing ministries, and project management sectors. However, 16 of them participated in the interview. The choice of the participants, who gave their agreement voluntarily, was essential for the reliability and applicability of the study. The interviews for this study were supposed to take 30 minutes apiece, but the shortest session spanned 40 minutes, while the longest one was 60 minutes because the interviewees desired to delve further. This further demonstrates that dry construction is a pressing topic within the construction field and is of interest to the important players.

3.4 Data Analysis

The thematic analysis technique, which Aronson (1994) characterised as appropriate and adaptable for gathering and expressing thoughts and emergent themes during an interview, was used to examine the participant's responses. Thematic analysis is an absolutist or realist approach that documents participant perspectives, interpretations, and facts, and sometimes it is a constructionist approach that looks at how occurrences, facts, understandings, experiences, and the like are influenced by a variety of societal perspectives (Braun & Clarke, 2006). Consequently, the conversations during the interviews with the participants were recorded, translated, and subjected to recurrent analysis. With the respondents' permission, the interview was conducted online, recorded using Microsoft Teams, and transcribed using Microsoft Office 365. Thanks to the recording, no qualitative information was missed throughout the interview session, which also allows for a precise translation.

Braun and Clarke (2006) identified six processes for analysing qualitative data: (1) Getting acquainted with collected data, (2) Creating preliminary codes, (3) Searching for recurring themes, (4) Examining themes again, (5) Classifying and Identifying themes, and (6) Generating the report. This research applied these processes.

1. Getting acquainted with collected data: The authors translated the 16 interviews verbatim and double-read them. The interviewer's details, including profession and years of experience, were noted and highlighted in a table. Statements that supported the study's questions were indicated with a distinct font colour.
2. Creating preliminary codes: During this stage, significant assertions were indicated with another font colour and were accompanied by explanations of their implications. For example: "legal framework compliance", "engagement of unqualified professionals", **"availability of materials", "**unsuitable working environment", "immigration policy", "cost acceptance", "training", "redundancy", "human nature", "inflation", "insecurity", and "impoverishment". All the transcribed interviews underwent this process. After the procedure was completed, more than 50 significant assertions were coded.
3. Search for recurring themes: A comprehensive theme was created by grouping related codes found in phase 2 together, such as "challenges affecting housing delivery", "approach of dry construction method", "**success factors for implementing DCM", "l**ack of awareness of DCM", and "impact of DCM on traditional professional/Craftsmen", among others.
4. Examining themes again: At this stage, the authors reviewed the themes and sub-themes a second time and had them examined by other specialists in the field of housing construction (Hayfield & Huxley, 2015). The inconsistencies found throughout the coding process were handled by careful consideration to make sure the outcomes aligned with the information gathered and the theoretical frameworks that addressed the study questions. The themes and sub-themes were then illustrated in a map.
5. Classifying and identifying themes*:* Every primary topic was given an overview and introduction in the discussion of the outcome, and the related sub-themes were then addressed.
6. Generating the report: The main themes that evolved from the investigation are included in the results and discussion section.

The research method featured four primary themes: challenges affecting housing delivery, the dry construction method, traditional professionals/artisans, and the adoption of dry construction. These themes served as preconceived codes of the study and gave it direction. More specifically, the themes were chosen to ensure that participants had technical understanding in at least one of them since dry construction is a developing sector of the construction industry, and the connections between those sectors still need to be well established. However, the most important concepts and keywords were coded, examined, rearranged, and compiled under pertinent themes. Data excerpts such as "legal framework compliance," "engagement of unqualified professionals," "over-reliance on traditional construction method," "inflation," "insecurity," and "impoverishment" were, for example, grouped under the theme "challenges affecting housing delivery". The categorised excerpts were extensively examined, and extensive analyses of the many patterns, trends, or linkages were developed.

4. Result and Discussion

Table 1 shows the research participants. They have different levels of work experience, with a minimum of five years and a maximum of 20 years, to ensure an in-depth understanding of the subject topic and guarantee that their awareness and information are current and not obsolete.

4.1 Challenges Affecting Housing Delivery

The study identifdied numerous factors contributing to the difficulties in housing provision in Nigeria based on the theme drawn from the transcribed records. The codes generated from the data collected include: legal framework compliance, engagement of unqualified professionals, over-reliance on the traditional construction method, inflation, insecurity, and impoverishment.

Table 1: Details of the interview participants

Code No	Role	Years of Experience Construction	Years of Experience in DCM	Organisational size	Location (Nigeria)
P1	Construction manager	15	8	Medium	Lagos, Cross River
P2	Project manager	15	8	Medium	Port Harcourt, Kaduna
P3	Builder/Contractor	15	8	Small	Ogun, Lagos, Nigeria
P4	Architect	15	15	Large	Abuja, Lagos, Benue
P5	Civil engineer	13	9	Medium	Abuja, Kwara
P6	Mechanical engineer	13	9	Small	Lagos, Anambra
P7	Project manager	13	10	Large	Niger, Imo
P8	Technical Coordinator	12	8	Medium	Lagos, Nigeria
P9	Planner	12	8	Medium	Lagos, Nigeria
P10	Cost manager	10	7	Large	Ogun, Abuja, Nigeria
P11	Project Engineer	10	5	Large	Kano, Delta
P12	Project manager	10	6	Medium	Lagos, Osun
P13	Builder	7	4	Medium	Ebonyi, Delta
P14	Technical Supervisor	6	6	Medium	Lagos, Oyo
P15	Civil Engineer	6	6	Small	Kaduna, Kano
P16	Mechanical Engineer	5	5	Medium	Lagos, Port Harcourt

4.1.1 Legal framework compliance

Enabling laws in Nigeria is one of the causes of the housing shortage, according to Participant P1, P2, P12, P14, and P17. Although there is a legal structure, it needs to be upheld as it should, which has allowed unqualified individuals to participate in building operations. Moreover, according to Participant P2, the government is not genuinely enforcing the enabling legislation as issued. Participant P1 noted that:

"Many people migrate to urban areas because there is no infrastructure to support them in rural areas. If there is infrastructure in rural areas, many people will not rush to urban areas where land costs are exorbitant. Then, many substandard materials are on the market, contravene building regulations" (P1).

This opinion supports Diogo's (2004) claim that despite massive expenditures on housing during various stages of the National Development Plan, the government has achieved few or no corresponding outcomes because of the government's paucity of genuineness and politicisation of the intervention. It also reflects the assertion made by Ojoko *et al*. (2016) that the Nigerian construction industry has struggled to develop in critical areas due to a lack of law and regulatory policy compliance, leaving the number and value of the nation's housing supply to decline.

4.1.2 Engagement of Unqualified Professionals

According to P2, P3, P5, P10, P14, P15 and P16, using unqualified employees in construction delivery could also be attributed to the recent trend

of building collapse in Nigeria. Interviewee P2 commented as follows:

"Because the government is not enforcing the enabling laws as issued, the involvement of quacks in the building is causing much havoc. You can have bad artistry, cost overruns, project delays, and poor quality" (P2).

Housing and even large engineering projects are impacted, resulting in poor building delivery quality. Therefore, it is necessary to streamline unprofessional contractors from the construction business by tidying up Nigeria's regulatory framework for concession delivery. This evidence backs up Olusola's (2014) assertion that Nigeria's construction industry is infested with shady, untrained contractors, whose involvement has caused numerous building collapses in the past and currently.

4.1.3 Over-reliance on the traditional construction method

According to Participants P3, P5, P8, P13, and P14, another factor influencing house delivery is an overreliance on traditional building methods. These methods include utilising a conventional methodology of placing blocks, waiting for them to dry, plastering them, and painting them. This lengthens the construction phase and shortens the time it takes to complete a building, as seen in the views expressed by P13:

"We are yet to get ourselves acquainted with modern technology, which is fast and quick, as we have it in first world countries, which is making them advance and then be able to deliver housing that will meet the demands of their citizens" (P13)

Again, this supports the argument made by Kalu *et al*. (2014) that Nigeria must embrace a different strategy to address its housing crisis because traditional construction methods have been employed for years but have yet to be successful due to various socioeconomic factors. Furthermore, it supports the contention made by Andalib and Gharaati (2012) that the growing demand for affordable housing in developing nations necessitates using quick and premium construction techniques that will shorten building duration and weight and produce more structurally sound buildings.

4.1.4 Inflation

Inflation, according to P1, P2, P6, P7, P11, P13 and P15, is another issue that Nigeria is facing that is hurting the delivery of housing. Due to the impact of inflation on construction materials, most people cannot afford quality materials, forcing them to settle for inferior materials of lower quality and grade. Participant P2 cited the following example:

"You must have heard in the news, I think, sometime last year about a building story collapse in Ikoyi, an eyebrow area in Nigeria. One of the primary reasons the building collapsed was that the owner didn't strictly follow the structural engineer's advice regarding material quality, and the structural engineer had to withdraw his services from the project" (P2)

While Participant P11 stated that:
"*We started a project and imported some materials in January 2022 when forex was obtained at a specific rate, but there was a spontaneous increase of roughly 40% in June 2022, which eventually affected the project massively"* (P11).

Musarat *et al*. (2021) agreed that inflation, frequently ignored in most construction projects' finance and planning, leads to construction expenditure overruns because building material and labour costs, and equipment hiring rates fluctuate yearly. Oghenekevwe *et al*. (2014) added that Nigeria's inflation patterns have not been consistent and unevenly impact construction material costs. Furthermore, Kalu *et al*. (2014) highlighted that almost all building materials, except sand, masonry, and timber, are imported. All other components are unavailable domestically and, therefore, more expensive and prone to inflation, which validates the finding.

4.1.5 Insecurity

People have been internally displaced around the country due to security concerns. They include those who were displaced by terrorists or bandits. People who had previously built homes were again forced into homelessness due to insecurity. Participant P12 viewed that:
"Many people believe that if we inculcate this Dry housing construction here in Nigeria, they only believe it is suitable for internal partitions because Nigeria is not that secure. If we adopt this system for external walls, there may be burglars who will bud through these walls and then start to pilfer people's goods and items" (P12).

This finding is consistent with the study conducted by Kamta *et al*. (2020), in which all 204 internally displaced people who were interviewed cited insecurity as the primary cause of their displacement from their locality of residence. Jelilov *et al*. (2018) added that Nigeria's insecurity level has been rising over time, posing a severe threat to individuals and property, impeding economic activity, and discouraging both domestic and international investors.

4.1.6 Impoverishment and lack of access to mortgage facilities

Mortgages are one of the private interventions available to mitigate the housing crisis; however,

each mortgage requires collateral or a stable job. As opined by Participants P1, P2, P3, P5, P8, P11 and P14, many people live below the poverty threshold, and the high unemployment rate presents another significant obstacle to home availability. The following views are expressed by Participants P1 and P4:

"What we call the Housing Fund and the National Housing Fund are government intervention programs that ensure housing funds are accessible. By and large, there's no concrete measure from the government to solve this housing problem in Nigeria because the processing is one of the problems, except you know the person in charge which made it difficult for people to access these facilities" (P1).

"There is poverty in Nigeria now; for you to talk about building, you must first talk about employment. Many people are living below the poverty line, so this has caused people to be homeless. You know, people look for food first, what to put in their mouth first" (P4).

This supports the findings of previous research by Anthony *et al.* (2017) that, given the nation's current economic state, more than 65% of Nigeria's populace lives in poverty, making less than $1 on average daily. They added that, in contrast to several industrialised nations that have already embraced diverse strategies, such as using government-launched affordable housing initiatives without a designated income range, when finished, the houses are allocated to a select number of wealthy and influential people (Anthony, 2017).

4.2 Practices of the Dry Construction Method (DCM)

Some of the codes generated from the interview responses include the approach to DCM, suitable materials for DCM, and deciding factors in implementing DCM.

4.2.1 Approach of the Dry Construction Method

Participants P1, P2, P3, P4, P7, P8, P12 and P15 stated that dry construction involves avoiding the use of cement, wet concrete, and raw masonry for construction. Participants P1, P2, P8 and P9 described the traditional method, known as the "wet method," uses water for most buildings' structural elements, including reinforced concrete columns, beams, walls, and slabs. Participants P11 and P16 viewed that:

"Many people believe that the dry building approach is only used when the entire project is constructed out of dry materials, not because dry construction is sometimes combined with the wet construction method, which we call hybrid construction (P11)".

"Some experts consult us for a wall that is slimmer and not more than 100mm as against the traditional 225 to 230mm thick walls. You know the weight of the system we practice (DCM) is approximately 10 times lighter than the wet (method), wet is about 2:50 kg per square meter in width, while dry is about 25 kg." (P16)

The above findings are consistent with Ademiluyi and Raji's (2008), and Andalib and Gharaati's (2012) statement that dry components like timber and fibreboard are utilised in DCM as a replacement for cement or mortar, brickwork, or stones in the traditional approach. They are further backed by the report on the Kalsi Board, which is produced in various thicknesses and dimensions ranging from 6mm to 20mm and produced under stringent operational reliability and safety control (Adegboye, 2015). Furthermore, the findings are validated with the assertion of Adegboye (2015) that, when compared to the wet technique of building, which uses mortar and brickwork, the approach is more widely applicable and expedient, with the potential to cut project duration by around 70%.

4.2.2 Suitable Dry Construction Material

4.2.2.1 DCM Materials and Methods

Participant P4 noted that the dry construction method is most often prefabricated. In other words, the building components are already manufactured and must be put together on-site from the superstructure to the roofing level. Although various forms and materials exist, the integrated building system is the most prevalent. According to Participants P1, P2, P4, P9, P12, P14 and P15, timber, steel galvanised, aluminium frames, fibres, member plasterboard, and other materials are some of the elements utilised in DCM,. The following are the views attributed to Participant P9 and P4:

"You know, it depends on the environment. In Nigeria, we don't season wood as such. So, if you use wood in Nigeria, I can assure you that the building will have issues. That is why we use aluminium, and aluminium is lighter, more durable, and is more fire resistant" (P9).

"Up onto the roofing level, there are different materials and different forms. The system we practice is the integrated building system. That comprises the framing system, which mostly consists of galvanised steel frames and the cladding of the framing" (P4).

This view was corroborated by Adegboye's (2015) finding that DCM is also a construction method in which the main construction materials are made in a workshop and installed on the construction site without the use of cement. Furthermore, AMR (2020) categorised DCM into five sections, notably form, structure, material, and implementation.

4.2.2.2 Factors influencing the choice of a suitable Material for DCM

P1, P2, P4, P6, P7, P10, and P13 emphasised that factors including availability, environmental conditions, cost, skill levels, and other considerations could help determine which material's benefit is best. However, P2 asserts that despite being readily available, timber has not been widely used in Nigeria due to the poor quality of timber seasoning and preservation in the country. As a result, steel, which is stronger, more durable, and fire-resistant, has become more popular.

4.3 Impact of DCM on the traditional professional/Craftsmen

Some of the codes developed regarding the replies were categorised into success factors, barriers, and mitigating measures for the implementation of DCM. The willingness to change, improved client satisfaction, collaboration, training, and hybrid construction emerged as success factors. While barriers include human nature and redundancy.

4.3.1 Success Factors

4.3.1.1 Willingness to Change

Participants P7, P11, P13, and P15 stressed that even though the professionals cannot immediately understand the full implications, professionals willing to accept the change and not dogmatic about the traditional approach may find that the impact is minimal or nonexistent. According to Participant P7:

*"Those willing to try something new will not see it as a challenge. As time passed, you saw carpenters using hand saws or hammers to work, but along the line, when machines came, many of them didn't use hand saws again but circular sawing machine*s."

4.3.1.2 Improved Client Satisfaction

Participant P3 opined that the new technology would impact neither professionals nor artisans. Instead, they would be receptive of its adoption because it would complement the traditional approach and lead to the completion of projects to the end users' satisfaction. Additionally, it will enhance technology in the building sector, as most experts anticipate.

4.3.2 Barriers

4.3.2.1 Human nature

Participants P1, P7, P9, P11, P12 and P14 viewed "human nature," which is unprepared for competition, as the first impediment to the introduction of DCM to the country. The country is suffering greatly as a result of its inability to experiment and attempt new initiatives because new and varied technologies must be explored to increase capacity. Participants P12 and P7 expressed the following views:

"You know everybody is a human being, and as human beings, a lot of times as professionals, you are not happy when you see a set of people that are marketing a more sophisticated or more recent method that will want to threaten your existing knowledge and threaten your relevance in the industry" (P12).

"Some of our core professionals are resistant, and then they put up a fight when they feel you're calling yourself younger and innovative and you want to introduce a system that we throw them out of relevance" (P7).

4.3.2.2 Redundancy

According to Participant P2, if DCM is employed on a large scale, it will undoubtedly have an impact on traditional professionals, notably craftspeople. The implication is that their knowledge won't be valuable in that capacity any longer, necessitating them to hone their abilities somewhere else. In addition, P1, P5, and P8 said that change is constant and that the adoption of DCM will likely put some people out of business while hiring new ones. For instance, when DCM is fully implemented, artisans in the bricklaying business will likely fizzle out.

4.3.3 Mitigating measures

4.3.3.1 The public and private sectors collaborate to develop innovative policies.

Participant P5 argued that the potential adverse effects of DCM implementation on traditional artisans and professionals should not be used as a rationale to dissuade or preclude the practice. In Participant P5's view, the overall advantages that DCM will impart to the industry surpass the disadvantages. Therefore, P5 advised that the construction industry should collaborate with the government to develop policies that can be implemented to lessen the negative impacts of DCM use.

4.3.3.2 Training

Participants P1, P2, P4, P5, P6, P7, P8, and P9 identified training, orientations, symposiums and workshop programs as the best ways to mitigate the effects that the adoption of DCM could have on conventional professionals and artisans. These will enable specialists and craftspeople to adapt to the new approach and maintain their relevance in the industry. Participants P5 and P4 made the following recommendations:

"What I think should be put forward more now is the training, orientations, re-orientations, and even workshop programs to help these people align with, if not, they'll be left behind" (P5).

"We make each major site a learning site so that with every major project we do, we finish the project with a new set of installers. You know that can

handle tools, materials, the board, and the frames" (P4).

4.3.3.3 Hybrid Construction-Success Factor

Participant P4 highlighted that the concept behind dry building is not to remove wet construction altogether or other construction methods already in use but rather to use them as a complement for a better and more sustainable construction sector, especially in meeting housing demand. P5 stated that one of the best ways to minimise the impact that the adoption of DCM can have on conventional professionals and artisans is to promote and practice hybrid building, a mix of DCM and other construction methods. This was evident in the following remarks made by Participant P8 and P5:

"I want to draw your attention to this: We can't completely eliminate wet construction because, first, most foundations are wet. So dry construction is not here to replace wet construction, but it is here to make the work easier, and there is this kind of finish that you get with dry construction that you cannot get with wet construction" (P8).

"We market our system as complementary, so we tell them to let us do hybrid, as you might have a project where you need a dry system. You want it to be completed in a short period, and you don't have all the luxury of time to wait for 21 days for your concrete slab to cure" (P4).

These findings are consistent with Andalib and Gharaati's (2012) recommendation that to maximise the effectiveness of construction practices in emerging nations; it is advantageous to combine DCM's versatility with other varieties of construction, including, masonry, metal, cement, or wooden structure building projects. By utilising the fundamental DCM materials, the structure would experience reduced dead weight than traditional construction techniques alone, ultimately translating into thinner building structures and decreased project costs (Andalib & Gharaati, 2012).

4.4 Barriers to the Implementation of DCM

Some of the themes drawn from the responses include Lack of awareness, Cost acceptance, Immigration Policy, and Unsuitable working environment.

4.4.1 Lack of awareness of DCM

Participants P1, P2, P3, P5, P8, P9, P11, P14 and P15, agreed that there still needs to be a higher level of awareness about DCM. It is a new form of building construction that was introduced to the country about 30 years ago. Some of the opinions of the interviewees are indicated as follows:

"Although it will take some time for the method to gain widespread acceptance, people are gradually accepting it, but only 10% to 15% of the country's population is aware of it or uses it now" (P15).

"The level of acceptance has increased from where it was five to ten years ago because it is now gradually making its way into the construction industry through yearly exhibitions and professional symposiums" (P14).

"Dry construction is not wholly new to the country because it has been employed for various building components over the years, such as the roof, ceiling, doors, and windows" (P7).

This finding is consistent with the observation of Obinna-Esiowa (2018) that introducing the dry construction method in residential housing delivery is moving slowly amid calls from specialists for Nigeria's construction sector to embrace the approach to address the housing deficit. Adegboye (2015) shared similar views, noting that the dry construction method has a knowledge deficit and that the building sector needs to ensure that effective learning is constantly increasing.

4.4.2 Cost Acceptance

Participants P1, P2, P3, P4, P5, P7, P8, P10, P13 and P15, viewed that depending on the size of the deployment, DCM is substantially more expensive than traditional methods. The participants expressed the following views based on their experience:

"There are still some challenges in the area of costs because you know a lot about Nigeria. Now, the bulk of the materials are imported. And then, depending on the scale of deployment, if it is a small deployment, it still sometimes comes to about 10 to 15% and is more expensive than the traditional way" (P13).

"An example was a client we lost because he wanted to finish a 3-bedroom flat with a budget of N8 million using the traditional method but was presented with a budget of N11 million with the dry method" (P4).

"One thing that we have observed over the years is that the combination of wet and dry methods makes clients feel more at ease because it has proved to be cheaper than using only the dry method" (P8).

These views are corroborated by research done by Ashiru and Anifowose (2020), which identified cost as one of the main obstacles to the advancement of low-cost construction in Nigeria. It was also affirmed that DCM is more costly than traditional methods and has increased the cost of housing projects by requiring more investment in infrastructure, logistics, and technical services (Andalib & Gharaati, 2012).

4.4.3 Immigration policy

Another challenge noted by Participants P3, P4, P9 and P10 is the frustrating immigration policy. According to P3, there are numerous impediments to the immigration process, starting at the clearance point for imported goods at the seaport. These delays result in delivery delays that consequently raise the overall cost of these materials and, ultimately, the cost of construction. Participant P4 observed that:

"Multiple taxes, both known to the government and unknown to it, have hampered the seamless importation of goods, which is another issue related to the immigration challenge we face when importing materials" (P4).

4.4.4 Unsuitable working environment

Nigeria's unfavourable working conditions, such as the epileptic power supply and exploitation by so-called landowners, were identified as a significant challenge for even conventional construction, let alone DCM, which primarily relies on electricity and frequently requires the use of generators. According to Participant P2:

"An example is the 52-housing duplexes project we recently completed. We operated mostly on generators, barely having electricity on the site for 2 hours daily out of 8 working hours. You know, this raises the project's overhead costs and invariably impacts the entire cost of delivering the project" (P2).

4.5 Success Factors for Implementing DCM

There was concensus by participants regarding the success factors for implanting DCM. They agreed that DCM is an overdue technology that developing nations like Nigeria should have implemented to address the housing shortage. However, several factors and measures must be implemented to guarantee the effective and practical adoption of DCM. The success factors for adopting or applying DCM that emerged in the study are weight, time, durability, flexibility, awareness, training, availability of material, and mortgage facilities.

4.5.1 Weight

Participants P4, P7, P12, and P15, stated that DCM is rapidly gaining acceptability, particularly among professionals, due to client education and understanding of the method's effectiveness, characteristics, and advantages.

"We carried out some laboratory experiments, and we found that DCM weighs roughly 25 kg per square meter, whereas the traditional (wet) method weighs about 250 kg per square meter. This means that the dry method is typically 10 times lighter than the wet" (P12).

This finding is supported by Andalib and Gharaati (2012) who deterrmined that DCM produces more financially sustainable construction in combination with shortening project duration and lightening overall structural weight. In addition, dry construction methods are found to provide a crucial approach to solving the construction issues of the present and the future by effectively meeting their demands with an imperceptible lightness (ITF, 2011).

4.5.2 Time

Participants P1, P7, P8, and P11 viewed that professionals had convinced clients of additional time-saving benefits, such as its quick construction method, to justify the cost disparity between DCM and wet construction. Compared to the wet method, which requires a specific amount of time to account for the concrete's curing, the DCM requires less time to complete because various construction stages can be completed concurrently and without any delays. Participants P11 and P4 noted as follows:

"When we talk about the speed of construction, a dry system is one of the fastest methods of construction because it involves assembling prefabricated products. From experience, I can tell you that you can save about 60% to 70% of construction time when using the dry system compared to the wet method" (P11).

"You know, dry construction has been adopted to solve lots of challenges, like when you want to deploy something lightweight and fast, like within a month or even weeks, sometimes probably because you do not have all the luxury of time of waiting for 21 days for your concrete slab to cure" (P4).

This aligns to the findings of earlier studies by Adegboye (2015) that the DCM strategy is more widely applicable and quick, with the ability to reduce project duration by about 70%, when compared to the wet technique of building, which uses mortar and brickwork. Additionally, according to the position taken by Andalib and Gharaati (2012), careful specification and dry connection arrangement play important roles in the DCM construction approach, reducing project duration and wastage due to the trial-and-error approach of untrained personnel.

4.5.3 Flexibility

The flexibility of DCM, was noted by Participants P1, P4, P7, P9, P12, P14, and 16, as another attribute it possesses and promoted by experts. Some specialists desire flexible buildings so that if adjustments are needed, they may loosen a portion of a wall and move it to a more suitable location by structural recommendations. Participant P4 noted as follows:

"There are a couple of professionals too that used to raise the issue of flexibility, but you know we proved to them that when they operate with dry construction, if they need to make changes, it's just a matter of loosening a part and introducing their new changes" (P9).

These findings are supported by Richard's (2006) conclusion that the key techniques for accomplishing high, affordable, and sustainable infrastructure that DCM offers are those that generate manufactured goods and composites in an industrial setting, establish flexible structures, and give components the capacity to be disassembled and reassembled for potential prospective modifications. ITF (2011) also stated that, unlike any other building approach, DCM offers complete technical capability, flexibility, and architectural autonomy while minimising required inputs.

4.5.4 Awareness

4.5.4.1 Education-based awareness

The participants viewed that to provide students with a firm basis in the technologies used in the industry, DCM awareness needs to be brought back to the classroom. The following is a recommendation made by Participant P7:

"The first thing is that the built environment should look into the syllabus used in schools to produce graduates and try to align that syllabus with what is happening in the industry. Believe me, someone can do a five-year course in the university, and the only time the person will hear of dry construction may not even be during a three-hour lecture" (P7).

4.5.4.2 Professional-based awareness

The early adoption of the technology emerged from the study as another important factor. To aid the acceptance of the technology by the professionals, who will then educate the end users and clients, a lot of background work, sensitisation, symposiums, exhibitions, and other techniques of awareness need to be done. Overcoming the experts' initial resistance will be a step ahead because experts can readily raise awareness among both their corporate and individual clients, which will help the method gradually gain popularity in the industry and society.

4.5.5 Availability of Materials

The participants P1, P2, P4, P5, P6, P10, P13 and P16 viewed material accessibility as essential for the adoption of DCM on projects. In some instances, according to P4, a client paid a more significant portion of a bill that has been submitted to them, but materials run out and need to be replenished. Market value had changed due to import-related inflation, frequently leading to a significant cost differential that could not be passed on to the customer. The following suggestions were made by some of the respondents to address the challenge of material availability:

"Our economic policy is not encouraging, and the fact that we are bringing all the materials from external countries increases the cost delivery of housing projects, which also scares people away from the method" (P10).

"The government should target investors to start building factories where they produce steel, Rockwool, and board to reduce the cost of those materials, it will go ahead to solve so many issues and probably allow many professionals to accept the technology" (P5).

This finding is congruent with Kulkarni *et al*. (2017) that materials account for more than 70% of project costs and, if not addressed appropriately, could impact total project costs and delivery timeline. Moreover, according to Ademiluyi and Raji (2008), several housing fairs and exhibitions at trade shows throughout the nation aimed to use locally sourced materials and suitable technologies in the provision of housing due to the belief that the adoption of a variety of innovations, from moderate to indigenous, will significantly affect the nation's strategy for delivering housing.

4.5.6 Training

Participants P2, P4, and P9 noted that a significant obstacle to the deployment of DCM in the past was the lack of skilled manpower. Due to DCM's recent introduction as a technology, unlike the traditional approach, craftspeople are not widely obtainable. P2 shared a painful experience of repeating most of the work on the first DCM project he worked on because most artisans were not well-versed in its use. The following recommendations were made:

"The government can have a training institute instead of the few private ones that we have, the private ones are where there are very few, they can have a lot in multiple zones to train people about it, because either we like it, or not dry construction aids you to know faster delivery of projects" (P2).

"So majorly what we need is training and workshop programs, train more artisans, more hands, more seminars, and expose people to the rudiments of dry construction, even if it is just the basics" (P9).

This supports the findings of Ashiru and Anifowose (2020), who concluded that the DCM has a skill deficit and suggested that the construction sector should significantly increase skill acquisition with constant coaching to ensure innovation is maintained in Nigeria. Andalib and Gharaati (2012) added that these systems might increase the probability of project success through off-site production technologies if the applicable skilled workman is provided with the proper learning context.

4.5.7 Mortgage facilities

Participant P3, P4, P5, P9, P13, and P14 noted that each person's financial circumstances should be considered because not all people can afford to buy a house outright, which is the approach frequently used in Nigeria. According to P5, the country's mortgage system needs to be revived, and this would require effort from both the government and private sector to develop a system that allows a citizen to own a home without paying the price of the home upfront. Participant P3 suggested as follows:

"The government can do something there, they should do a pre-qualification exercise for the average person, If you are qualified, then people have access to a mortgage that can help them to Have their buildings" (P3).

This can be contrasted with the study done by Ademiluyi and Raji (2008) and Anthony *et al*. (2017), which found that the bulk of public and corporate builders raise cash for the financing of construction developments independently; some go so far as to raise loan repayments. Ademiluyi and Raji (2008) recommended that mortgage loans should not only be used to build new homes but also allow individuals to rent housing and start improving established homes.

5. Conclusion

This study aimed to identify the factors contributing to the housing shortage in Nigeria and explore the current level of application of the Dry construction method in mass housing delivery. The study found that the main factor influencing the limited housing availability in Nigeria is the need for adherence to the regulatory framework, which has allowed unskilled workers to infiltrate the construction sector. Furthermore, the results showed that industrialised housing construction in Nigeria seems unattainable because of the country's excessive reliance on antiquated methods, its unstable economy and increased rates of insecurity, and its lack of access to mortgage facilities, all of which are critical issues that need to be addressed for DCM to be fully implemented and for construction to become more industrialised.

This study revealed that DCM is not entirely new to the country because it has been used for various building components, including the roof, ceiling, doors, and windows. In terms of DCM awareness, the data collected showed that it has grown more widely known and accepted than it was five to ten years ago (2014-2019) since it is now progressively entering the construction sector through yearly exhibitions and professional symposiums, along with a general comprehension of the efficiency, capabilities, and benefits of the method. The study also found that, despite being widely available, timber has not been extensively utilised in Nigeria's construction industry because of the country's subpar seasoning and preservation practices. Steel has gained popularity due to its strength, durability, and fire resistance. Despite the established evidence that DCM can solve housing challenges, the study's findings revealed that DCM could be significantly more expensive than conventional methods depending on the deployment size, with a predicted increase in costs of between 10% and 15% compared to wet methods. However, the results demonstrate that the benefits of DCM, such as its speedy construction method, have been successfully employed to justify the cost discrepancy, with an estimate of a reduction in construction time by 60 to 70%, particularly when compared to wet construction methods (WCM). The research also revealed that DCM is as durable as WCM because it would take the same amount of force needed for WCM if not more, to destroy a drywall when using a sledgehammer.

The study identified several obstacles to the adoption of DCM, such as inflation, difficulty persuading clients because of the high cost associated with it, difficulty obtaining the necessary materials because of a troublesome immigration policy, and the overall unsuitable working environment of the nation. However, based on the empirical findings, the research recommends certain factors to ensure the success of DCM adoption. These include the Ministry of Works and Housing and the Nigerian Federal Housing Authority making sure that legal frameworks are followed, investing in ongoing training, ensuring that the necessary materials are available by encouraging local production, and ensuring that housing mortgages are affordable for the average citizen. Furthermore, the evidence presented in this study contributes to the knowledge of housing delivery practices using innovative and modern approaches, in Nigeria, which has housing delivery challenges. Firstly, identifying the current approach used in applying DCM in housing delivery alongside its success factors would support future adoptions of the DCM in housing delivery, which could help close the housing gap. Secondly, identifying its success factors and the likely barriers would guide major stakeholders in the housing sector to make well-informed decisions and develop strategies for its implementation in housing delivery. Furthermore, the evidence presented in this paper could be used by government agencies to formulate policies that would encourage the use of DCM for effective housing delivery.

This study is based on qualitative interviews and is limited to Nigeria. As such, the results cannot be generalised and should be used with caution. However, the evidence presented could be used as a lens to direct future studies that aim to explore how to use innovative methods to address housing shortages elsewhere, especially in developing countries.

References

Adegboye, K. (2015). Dry construction solution for mass housing Nigerian boss. *Vanguard Nigeria*. Retrieved from https://www.vanguardngr.com/2015/02/dry-construction-solution-mass-housing

Ademiluyi, A. I., & Raji, B. A. (2008). Public and private developers as agents in urban housing delivery in Sub-Saharan Africa: The situation in Lagos State. *Humanity and Social Science Journal*, 312.

Andalib, H., & Gharaati, M. (2012). Dry construction method for developing countries: The case of Iran. *The International Journal of the Constructed Environment*, 2(2), 131-142.

Anthony, A., Daniel, D., Olusegun, O., Kabir, L., Gbenga, O., & Philips, A. (2017). Affordable and acceptable mass housing delivery: A panacea to the Nigeria housing problem. In *Conference of the International Journal of Arts & Sciences* (pp. 31–38). Nigeria.

Anyanwu, J. C. (1997). Poverty in Nigeria: Concepts, measurement and determinants. In *Poverty alleviation in Nigeria* (pp. 93-120).

Aronson, J. (1994). A pragmatic view of thematic analysis. *The Qualitative Report*, 2(1).

Ashiru, A., & Anifowose, K. (2021). An investigation into the application of dry construction technique in providing low-cost housing for Nigerians. *Civil Engineering and Architecture*, 9(1), 206–213.

Aule, T., & Jusan, M. (2019). Descriptive analysis of housing delivery problems in Nigeria and way forward. In *International Graduate Conference of Built Environment and Surveying* (pp. 1-10). Johor Bahru, Malaysia: GBES.

Aule, T. T., Ibrahim, S., & Chigozie, C. (2018). Industrial prefabrication as an effective approach to solving housing problems in Nigeria. *International Journal of Scientific Research in Technology, Applied Sciences & Health Studies*, 3(1), 36–49.

Bailey, C. A. (2018). *A guide to qualitative field research*. Thousand Oaks, CA: SAGE Publications.

Bell, M., Wingfield, J., Miles-Shenton, D., & Seavers, J. (2010). *Low carbon housing: Lessons from Elm Tree Mews*. York, UK: Joseph Rowntree Foundation.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101.

Brick. H. (2019). Brick or render? *Brick Hunter*. Retrieved from https://brickhunter.com/blog/brick-orrender/

Brigden, M. (2013). The pros and cons of brick and block construction. *The Green Home*. Retrieved from http://thegreenhome.co.uk/builing-products/brick-and-blockconstruction/

Crescentini, A., & Mainardi, G. (2009). Qualitative research articles: Guidelines, suggestions, and needs. *Journal of Workplace Learning*, 21(5), 431-439.

Daniel, E. I., Oshodi, O., Dabara, D., & Dimka, N. (2023). Towards closing the housing gap in the UK: An exploration of the influencing factors and the way forward. *Construction Innovation*, *ahead-of-print*.

David, L. A., & Emmanuel, A. (2018). Evaluation of risk of fluctuation claims on the cost of construction projects in the South-South zone of Nigeria. *Civil Engineering and Architecture*, 6(5), 252–256. doi:10.13189/cea.2018.060504.

Di Silvestre, C. (2020). Re: What is the difference between thematic analysis and grounded theory? Retrieved from https://www.researchgate.net/post/Whatis-the-difference-between-thematic-analysis-and-Grounded-theory

Diogo, J. O. (2004). Middle-income mass housing: A methodological approach. *Journal of Association of Architectural Educators in Nigeria*, 3(1), 24–29.

Ezeigwe, P. C. (2015). Evaluation of the causes of housing problems in Nigeria: A case study of Awka, the capital city of Anambra state. *Journal of Economics and Sustainable Development*.

Fewins, C. (2019). The pros and cons of different construction systems (PDF). Retrieved from www.cyprus-property-buyers.com/files/constructionmethods.pdf

Gelling, L. (2016). Applying for ethical approval for research: The main issues. *Nursing Standard*, 30(20), 40–44.

Halirova, M., Sevcikova, H., Fabian, R., Machovcakova, E., & Janousek, R. (2017). Optimization of composition of the claddings of wooden structures. In *Civil, Architecture and Environmental Engineering* (pp. 58-63). CRC Press.

Harrison, M. (2020). Re: Grounded Theory or Thematic Analysis? Retrieved from https://www.researchgate.net/post/Grounded_Theory_or_Thematic_Analysis

Harvey, W. S. (2011). Strategies for conducting elite interviews. *Qualitative Research*, 11(4), 431-441.

ITF. (2011). *International Dry Construction Conference*. Darmstadt, Germany, October 6–7.

Iwuagwu, B. U., & Iwuagwu, B. C. M. (2015). Local building materials: Affordable strategy for housing the urban poor in Nigeria. *Procedia Engineering*, 118, 42–49.

Jackson II, R. L., Drummond, D. K., & Camara, S. (2007). What is qualitative research? *Qualitative Research Reports in Communication*, 8(1), 21-28.

Jaillon, L., & Poon, C. S. (2009). The evolution of prefabricated residential building systems in Hong Kong: A review of the public and private sector. *Automation in Construction*, 18(3), 239–248. doi:10.1016/j.autcon.2008.09.002.

Jelilov, G., Ozden, K., & Briggs, S. O. (2018). Impact of insecurity on investment in Nigeria. *Journal of Management, Economics, and Industrial Organization*, 2(3), 41-61.

Jeong, J. G., Hastak, M., & Syal, M. (2006). Supply chain simulation modeling for the manufactured housing industry. *Journal of Urban Planning and Development*, 132(4), 217–225. doi:10.1061/(asce)0733-9488(2006)132:4(217).

Jiboye, A. (2011). Achieving sustainable housing development in Nigeria: A critical challenge to governance. *International Journal of Humanities and Social Science*, 1(9), 122–125.

Kalu, I., Agbarakwe, H., & Anowor, O. (2014). National housing policies and the realization of improved housing for all in Nigeria: An alternative approach. *Asian Development Policy Review*, 2(3), 47-60.

Kamta, F. N., Schilling, J., & Scheffran, J. (2020). Insecurity, resource scarcity, and migration to camps of internally displaced persons in Northeast Nigeria. *Sustainability*, 12(17), 6830.

Knauf. (2011). *The complete drywall manual*. Retrieved from https://www.scribd.com/document/589370890/KNAUF-The-Complete-Drywall-Manual

Kozlovska, M. et al. (2023). An expert knowledge-based system to evaluate the efficiency of dry construction methods. *Applied Sciences*, 13(21), 11741. doi:10.3390/app132111741.

Kulkarni, V., Sharma, R., & Hote, M. (2017). Factors affecting material management on construction sites. *International Research Journal of Engineering and Technology (IRJET)*, 4(1), 474–478.

Lye, L. H. (2020). Public housing in Singapore: A success story in sustainable development. *SSRN*. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3595956

Macieira, M., & Mendonça, P. (2016). Building rehabilitation with dry and wet systems: Embodied water comparison. *MATEC Web of Conferences*, 68, 13009. doi:10.1051/matecconf/20166813009

McLeod, J. (2001). *Qualitative research in counseling and psychotherapy*. Sage.

Musarat, M. A., Alaloul, W. S., & Liew, M. S. (2021). Impact of inflation rate on construction projects budget: A review. *Ain Shams Engineering Journal*, 12(1), 407–414.

Nazir, F., Edwards, D., Shelbourn, M., Martek, I., Thwala, W., & El-Gohary, H. (2020). Comparison of modular and traditional UK housing construction: A bibliometric analysis. *Journal of Engineering, Design and Technology*, 19(1), 164–186.

Obinna-Esiowu, D. (2018). Dry construction method and increased housing delivery project. *PropertyPro Insider*. Retrieved from https://www.propertypro.ng/blog/dry-construction-method-and-increasedhousing-delivery-project/

Oghenekevwe, O., Olusola, O., & Chukwudi, U. S. (2014). An assessment of the impact of inflation on construction material prices in Nigeria. *PM World Journal*, 3(4).

Ojoko, E., Abubakar, H., Ojoko, O., & Ikpe, E. (2016). Sustainable housing development in Nigeria: Prospects and challenges. *Journal of Multidisciplinary Engineering Science and Technology (JMEST)*, 3(5), 4851-4860.

Oliver, P. (2006). Purposive sampling. In V. Jupp (Ed.), *The Sage Dictionary of Social Research Methods*. Sage Publications.

Olotuah, A. O., & Aiyetan, A. O. (2006). Sustainable low-cost housing provision in Nigeria: A bottom-up participatory approach. In D. Boyd (Ed.), *Proceedings of the 22nd Annual ARCOM Conference* (pp. 633-639). Birmingham, UK: Association of Researchers in Construction Management.

Olusola, M. (2014). Housing delivery system, need and demand. *Environment, Development and Sustainability: A Multidisciplinary Approach to the Theory and Practice of Sustainable Development*, 16(1), 49–69.

Osuizugbo, & Chigozie, I. (2018). Traditional building – Construction problems: Need for espousal of sustainable construction in Nigeria. *International Journal of Scientific and Research Publications (IJSRP)*, 8(12).

Richard, R. B. (2006). Industrialized, flexible and demandable building systems: Quality, economy, and sustainability. In *The CRIOCM International Symposium on Advancement of Construction Management and Real Estate* (pp. 1-8). Beijing, China.

Schmuecker, K. (2011). *The good, the bad and the ugly*. London, UK: Institute for Public Policy Research.

Spradley, J. P. (2016). *The ethnographic interview*. Harcourt College, Waveland Press, Fort Worth, TX.

STBA. (2012). Responsible retrofit of traditional buildings (PDF). Retrieved from www.ihbc.org.uk/recent_papers/docs/STBAresponsible_retrofit2012.pdf

Taiwo, A., & Adeboye, A. (2013). Sustainable housing supply in Nigeria through the use of indigenous and composite building materials. *Civil and Environmental Research*, 3(1), 79-84.

Tam, C. M., Deng, Z. M., & Zeng, S. X. (2002). Evaluation of construction methods and performance for high rise public housing construction in Hong Kong. *Building and Environment*, 37(10), 983–991. doi:10.1016/s0360-1323(01)00081-6.

Tichelmann, K., & Pfau, J. (2008). *Dry construction: Principles, details, examples*. München: Birkhäuser.

Trochim, P. (2022). Research methods knowledge base. Retrieved from https://www.researchgate.net/publication/243783609_The_Research_Methods_Knowledge_Base