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Risk management in procurement options in project management: A case study of road construction in Luanshya

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Abstract
Risk management in procurement is a critical aspect of project management, particularly in road construction, where uncertainties can significantly impact project timelines, budgets, and outcomes. Effective procurement strategies help mitigate risks related to cost overruns, delays, quality issues, and contractual disputes. This study examines risk management practices in procurement options within the context of road construction projects in Luanshya. STATA was used for data entry and statistical analysis. Graphical presentation of descriptive statistics was done using Microsoft Excel 365. Chi-square was used for inferential statistics in order to determine the relationships between the variables. The findings revealed that the Design-Bid-Build (DBB) method is the most preferred procurement option, utilized in 40% of projects, due to its structured processes and defined roles. However, it is also linked to higher financial and time-related risks, such as cost overruns and delays. Design-Build (DB) follows at 26.9%, valued for its efficiency in reducing project timelines but carries risks tied to contractor reliability. Less frequently used methods, such as Public-Private Partnerships (PPP) and Integrated Project Delivery (IPD), offer unique benefits but face challenges in setup complexity and stakeholder coordination. Key factors influencing procurement method selection include project complexity, cost control, and time constraints. Risk analysis highlights that external factors such as regulatory challenges, economic fluctuations, and weather conditions significantly impact procurement outcomes. Current risk management practices were found to be moderately effective, with limitations stemming from inadequate risk assessment methods, insufficient training, and high implementation costs. To improve risk management in road construction, government agencies, construction companies, and stakeholders should institutionalize comprehensive training programs tailored to specific procurement-related risks, using real-world case studies for practical insights. Embracing hybrid procurement strategies, such as design-build (DB) and public-private partnerships (PPPs), can better distribute risks and enhance accountability. Developing a standardized risk assessment framework will ensure consistency and transparency across projects, while continuous risk monitoring systems can proactively address emerging issues. Multistakeholder collaboration through forums and workshops will promote shared responsibility and knowledge exchange.

Keywords: Road construction, procurement, risk management, construction industry, Luansya, Zambia

1. Introduction

1.1 Background

The construction industry, renowned for its intricate nature and vulnerability to multifaceted risks, is a critical driver of societal development (Smith *et al*., 2019; Ling *et al*., 2020) [26]. Within this expansive sector, road construction projects assume paramount importance, serving as linchpins for enhancing transportation networks and fostering economic growth (Chan and Yeung, 2019). The success of such projects, however, is contingent upon navigating an array of dynamic factors, including technological uncertainties, intricate stakeholder dynamics, and environmental considerations.

Technological uncertainties, characterized by the rapid evolution of construction methodologies, materials, and equipment, introduce an element of unpredictability to project planning and execution (Cheng *et al*., 2018; Zuo *et al*., 2021). The integration of innovative technologies and materials, while promising improved efficiency, also poses challenges in terms of adaptation and risk mitigation. Stakeholder dynamics further compound the complexity, involving the coordination and collaboration of diverse entities such as

government bodies, local communities, contractors, and suppliers (Osei-Kyei and Chan, 2017; Lu *et al*., 2020). The varied interests and perspectives of these stakeholders can significantly shape the trajectory of a road construction project, impacting its success or encountering unforeseen challenges.

Environmental considerations, paramount in the current era of sustainability, play a pivotal role in shaping construction practices, particularly in road projects that often traverse ecologically sensitive areas (Lo *et al*., 2018; Akadiri *et al*., 2021). The balancing act between infrastructure development and environmental preservation demands a meticulous approach. The repercussions of overlooking environmental factors can be severe, leading to legal complications, public opposition, and long-term environmental degradation.

Crucially, the procurement options chosen for construction projects emerge as pivotal determinants of overall risk exposure and subsequent risk management strategies (Chan *et al*., 2019; Zhai *et al*., 2020). The decision to adopt a particular procurement approach profoundly influences project dynamics, timelines, costs, and quality. Understanding the intricate nuances of risk management within the procurement domain is indispensable for achieving successful project delivery. This understanding goes beyond mere risk identification; it involves a comprehensive evaluation of risk mitigation strategies, proactive planning, and adaptability in the face of unforeseen challenges.

Recognizing the interplay between risk management and procurement is vital not only for immediate project success but also for ensuring the sustained functionality and longevity of the constructed infrastructure (Wang *et al*., 2019; Zhang *et al*., 2021) [31, 27]. The enduring impact of road construction projects necessitates a forward-looking and holistic approach to risk management, one that considers the entire project lifecycle and the broader socio-economic and environmental context.

In essence, comprehending the complexities of risk management in procurement within the realm of road construction projects is an imperative undertaking supported by empirical studies and scholarly contributions (Zhu *et al*., 2018; Chen *et al*., 2021). It forms the foundation for informed decision-making, resilience in the face of uncertainties, and the creation of infrastructure that stands the test of time, benefitting communities and economies alike.

1.2 Statement of the problem

Despite the growing awareness of the paramount importance of risk management in construction projects, a noticeable gap persists in the existing literature, particularly concerning the specific challenges and best practices associated with procurement options and risk management within the context of road construction projects in Luanshya (Wu, 2018; Hossain and Lowe, 2019). While the construction industry as a whole grapples with inherent complexities, the unique dynamics of road construction projects introduce additional layers of intricacy, spanning technological uncertainties, stakeholder intricacies, and environmental concerns. In Luanshya, a municipality undergoing infrastructural development, the challenges related to risk management in road construction projects become even more pronounced. The absence of a comprehensive understanding of these challenges may lead to suboptimal project outcomes, cost overruns, delays, and potentially, compromised infrastructure quality. This research seeks to address this critical knowledge gap by looking into the specific nuances of risk management associated with various procurement options in the context of road construction projects in Luanshya. The existing body of knowledge predominantly addresses risk management in construction projects at a general level, often overlooking the intricacies associated with procurement decisions and their implications in the unique context of Luanshya's road infrastructure development. As such, a focused examination of the challenges and opportunities related to risk management in procurement within the construction industry, with Luanshya's road construction projects as a case study, is imperative to fill this void and provide actionable insights for project stakeholders.

1.3 Main Objective

The main objective of this research was to conduct a thorough analysis of risk management in procurement options within the road construction sector in Luanshya.

1.3.2 Specific Objectives

- To explore procurement options used in road construction options used in road construction projects in Luanshya.
- To examine the risks associated with procurement option in the road construction.
- To analyze the effectiveness of current risk management practices in mitigating challenges related to procurement in the construction industry.
- To identify the challenges faced in managing procurement risks in the construction of roads in Luanshya.

1.4 Conceptual Framework

The success of any construction project hinges on effective procurement practices. Traditionally, procurement focused on reactive problem-solving. However, a paradigm shift towards proactive risk management has emerged as a critical strategy for mitigating disruptions and ensuring project success (Turner, 2014). This approach, formulated in the mid-20th century (Chapman, 2005) [8], emphasizes identifying and addressing potential problems early in the project lifecycle, particularly during the crucial procurement stage. This paper explores the concept of proactive risk management and how different procurement options, specifically design-bid-build (DBB) and design-build (DB), influence the ability to proactively identify risks in road construction projects within the context of Luanshya, Zambia.

Proactive risk management is a forward-thinking approach that prioritizes early identification and mitigation of potential issues before they escalate into costly delays or quality defects (Chapman, 2016) [8]. This proactive stance requires a shift from reactive firefighting to a systematic process that begins during the initial stages of procurement. By initiating risk analysis even before selecting a contractor, project managers gain a crucial advantage. This allows them to not only identify potential risks associated with the project itself, but also to assess the inherent risk profiles of different procurement methods.

2. Literature review

The global perspective on procurement options in road construction projects plays a crucial role in informing decision-making and ensuring successful project delivery (Smith *et al*., 2023) [27]. "Global Best Practices in Construction Procurement" by Smith, *et al*. (2023) [27] offers a comprehensive analysis of commonly used procurement options worldwide. The study delves into traditional models like Design-Bid-Build (DBB), Design-Build (DB), and Public-Private Partnerships (PPPs), providing in-depth understanding of their advantages and challenges (Smith *et al*., 2023) [27]. These findings serve as a foundational reference for understanding the diverse range of procurement options employed globally in the road construction sector.

A comparative analysis of procurement methods on a global scale is presented in "Comparative Analysis of Procurement Methods in Infrastructure Projects" by Chen, L. *et al*. (2022). This study emphasizes the importance of aligning the chosen model with specific project characteristics, highlighting the nuances of various methods (Chen *et al*., 2022). Chen's work provides insights into collaborative approaches like Design-Build, demonstrating how these models foster innovation and efficiency (Chen *et al*., 2022). However, potential limitations include the need for updates to capture evolving trends and potentially less detailed coverage of regional variations in procurement practices (Chen *et al*., 2022).

"Global Trends in Infrastructure Procurement" by Turner,. *et al*. (2021) [29] contributes to the understanding of the evolving landscape by identifying a global shift towards integrated project delivery (IPD) methods (Turner *et al*., 2021) [29]. The study reflects a broader industry trend of emphasizing collaboration and risk-sharing among project stakeholders (Turner *et al*., 2021) [29]. While Turner *et al*. (2021) [29] provide valuable insights into trends, their work could benefit from a more specific examination of the advantages and disadvantages of each procurement option.

The literature on global procurement options in road construction provides a robust foundation for understanding the variety of models employed internationally. These studies collectively emphasize the importance of tailoring procurement options to specific project requirements and local contexts (Smith *et al*., 2023; Chen *et al*., 2022) [27]. To enhance the practical application of these findings, it is crucial to complement this global literature with region-specific studies and up-to-date information to ensure that the chosen procurement options align with current trends and challenges in the field.

The literature on procurement options in road construction projects at the African level paints a picture of a continent grappling with diverse challenges and opportunities (Akintola, 2022) [3]. "Infrastructure Procurement in Africa: A Comprehensive Review" by Akintola (2022) [3] provides an encompassing examination of the procurement landscape in Africa. The study outlines traditional models like Design-Bid-Build (DBB) and newer approaches like Design-Build-Operate (DBO) (Akintola, 2022) [3]. It offers valuable insights into the complexities associated with infrastructure procurement in African countries, including issues related to funding, regulatory frameworks, and capacity constraints (Akintola, 2022) [3].

An in-depth analysis of broader public procurement practices in Africa, extending beyond just road construction, is found in "Public Procurement in Africa: Challenges and Opportunities" by Mbow *et al*. (2021) [21]. While the focus is broader, the study sheds light on overarching issues faced in public procurement across the continent, emphasizing the need for transparent and efficient processes (Mbow *et al*., 2021) [21]. This echoes the importance of addressing these challenges in the specific context of road construction projects (Mbow *et al*., 2021) [21].

The African Development Bank's report on "Infrastructure Development and Procurement Models in Sub-Saharan Africa" by AfDB (2023) delves into the procurement strategies adopted in various sub-Saharan African countries. The report highlights the prevalence of Public-Private Partnerships (PPPs) and the challenges faced in implementing these models (AfDB, 2023). Understanding the dynamics of PPPs becomes crucial as African nations seek alternative procurement approaches to address infrastructure development needs (AfDB, 2023).

While these studies offer valuable insights, it is crucial to acknowledge the potentially limited specificity regarding individual African countries or regions. "Regional Variations in Infrastructure Procurement: A Case Study of Zambia" by Chigunta (2022) [9] exemplifies a more focused approach, exploring the specific procurement options adopted in Zambia (Chigunta, 2022) [9]. This localized perspective provides a nuanced understanding of the challenges and successes unique to the region, offering valuable insights into tailoring strategies (Chigunta, 2022) [9].

The reviewed literature on procurement options in road construction at the African level reflects a growing awareness of the challenges and opportunities within the continent (Akintola, 2022; AfDB, 2023) [3]. To gain a comprehensive understanding, future research could benefit from more in-depth case studies and comparative analyses focusing on specific African countries or regions, similar to Chigunta's (2022) [9] work on Zambia. This targeted approach would contribute to tailoring procurement strategies that consider the diverse socio-economic, regulatory, and infrastructural contexts across the African continent.

The literature on procurement options in road construction projects offers valuable insights, particularly when examined from a Zambian perspective. While specific studies focusing solely on Zambian procurement practices might be limited, existing literature provides valuable context for understanding the broader infrastructure development landscape within the country (Mumba, 2023) [22].

A foundational reference in this regard is "Infrastructure Development and Procurement Practices in Zambia" by Mumba (2023) [22]. This study outlines the prevalent procurement options employed in the Zambian construction sector, with a specific focus on road infrastructure (Mumba, 2023) [22]. It explores traditional methods like Design-Bid-Build (DBB) and assesses the adaptation of alternative models like Design-Build (DB) within the Zambian context (Mumba, 2023) [22]. The findings shed light on the applicability and challenges of different procurement options within Zambia's unique regulatory and economic framework (Mumba, 2023) [22].

Furthermore, "Public-Private Partnerships in Zambian Infrastructure: A Procurement Analysis" by Mwale (2022) offers an in-depth examination of the role of Public-Private

Partnerships (PPPs) in road construction (Mwale, 2022). This study evaluates the effectiveness of PPPs in delivering infrastructure projects, considering factors such as financing, risk allocation, and stakeholder collaboration (Mwale, 2022). Understanding the nuances of PPPs within Zambia is crucial for policymakers and industry professionals seeking sustainable infrastructure solutions (Mwale, 2022).

While these studies provide valuable insights, it is essential to supplement them with industry reports and government publications for a more comprehensive understanding (Mumba, 2023) [22]. Resources like the "Zambia Roads Authority Annual Report" and "National Road Fund Agency Strategic Plan" offer instrumental insights into the overarching strategies and challenges in road construction procurement at the national level (Mumba, 2023) [22]. These documents provide a practical perspective on the implementation of procurement options, highlighting successes and areas requiring improvement (Mumba, 2023) [22].

Despite the available literature, a potential gap exists in recent and detailed case studies that specifically analyze the performance of different procurement options in recent Zambian road construction projects (Mumba, 2023) [22]. Future research endeavors could aim to fill this gap by conducting on-the-ground case studies, examining the successes and challenges faced by construction projects employing various procurement methods (Mumba, 2023) [22]. While the existing literature provides a foundational understanding of procurement options in road construction projects in Zambia, there is a need for more recent and country-specific research to inform current practices and policy decisions (Mumba, 2023) [22]. Future studies should focus on conducting detailed and practical case analyses, ensuring that the findings are tailored to the evolving dynamics of the Zambian construction industry (Mumba, 2023) [22].

Procurement in road construction projects involves selecting the most suitable method to acquire the necessary services and resources to complete the project efficiently and effectively. Various procurement options exist, each with distinct characteristics and implications for project outcomes. Understanding these options is crucial for stakeholders in Luanshya to make informed decisions that align with project goals, budget constraints, and risk management strategies.

The Design-Bid-Build (DBB) method is one of the most conventional and widely used procurement approaches in road construction. It involves three main phases: design, bidding, and construction. In this method, the project owner first engages a designer or an architectural firm to create detailed plans and specifications for the project. Once the design is complete, the project is put out to tender, inviting contractors to submit bids. The contractor with the lowest bid, meeting all criteria, is typically awarded the construction contract.

One of the primary advantages of the DBB method is the clear separation of roles and responsibilities between the designer and the contractor, which can reduce conflicts of interest and ensure high-quality design standards (Laryea & Hughes, 2011) [16]. However, this method often results in longer project timelines due to the sequential nature of the design and construction phases. Additionally, any design changes during construction can lead to significant cost overruns and delays (Rahmani *et al*., 2013).

The Design-Build (DB) method integrates the design and construction phases into a single contract, with the contractor being responsible for both designing and constructing the project. This approach aims to streamline project delivery by fostering collaboration between designers and builders from the outset. The DB method can significantly reduce project duration and costs since design and construction activities can overlap, allowing for more flexible and efficient project management (Love *et al*., 2012) [17].

The financial stability of suppliers is another crucial risk in procurement management. Financially unstable suppliers may face difficulties in meeting their contractual obligations, causing delays or even jeopardizing the entire project. Supplier bankruptcy can be particularly disruptive, halting the supply of essential materials or services and forcing the project team to find replacements on short notice (De, 2021). This not only leads to delays but can also escalate costs due to the urgency of securing alternative suppliers. Additionally, suppliers with financial difficulties may compromise on quality to cut costs, undermining the reliability of their deliveries. To mitigate these risks, thorough financial assessments and ongoing monitoring of suppliers' financial health are essential. This process may involve reviewing financial statements, evaluating credit ratings, and conducting regular financial health checks throughout the project lifecycle. Proactively addressing financial risks allows project managers to implement contingency plans, ensuring the continuity of supply and minimizing disruptions (Ahmed, 2022) [2].

The capability and capacity of suppliers are critical factors in their ability to meet project requirements (Costa, 2019) [10]. Suppliers who lack the necessary resources or expertise, particularly for complex projects, may struggle to deliver as expected. This mismatch between demand and supply can result in project delays and increased costs. Additionally, inadequate specialized skills or technology for specific project components can lead to subpar performance or necessitate extra training and support. To address these risks, thorough evaluations of potential suppliers are essential. This includes assessing their technical capabilities, production capacity, and track record with similar projects. Site visits, audits, and pilot runs can offer valuable insights into their ability to meet project demands. Building strong supplier relationships and maintaining open communication channels can also help identify and resolve capacity or capability issues early in the project lifecycle (Faruquee, 2021) [11].

Supply chain disruptions are another major market risk that can adversely affect project procurement (Kissi, 2021). Natural disasters such as earthquakes, floods, or hurricanes can damage infrastructure and halt production. Geopolitical issues, including trade wars, political instability, or sanctions, can further obstruct the flow of goods across borders, leading to delays and higher costs. A recent example is the COVID-19 pandemic, which caused widespread supply chain disruptions, affecting the availability and pricing of goods and services. Such disruptions can delay project timelines, increase costs due to alternative sourcing needs, and strain relationships with suppliers and stakeholders. Mitigation measures include diversifying the supplier base, maintaining strategic reserves

of critical materials, and developing robust contingency plans to ensure continuity during supply chain interruptions (Manners, 2023) [20].

The scarcity of certain resources also poses a significant challenge in project procurement. Limited availability of materials or components may arise from high demand, production constraints, or regulatory restrictions. This scarcity can lead to project delays and increased costs as competition drives up prices. Environmental regulations further exacerbate resource limitations by restricting the extraction or use of certain materials. To mitigate this risk, project managers should identify potential resource constraints during the planning phase. Strategies include securing long-term contracts with suppliers, exploring alternative materials or technologies, and investing in resource efficiency to reduce dependency on scarce items. Building strong supplier relationships and monitoring market trends can help project managers anticipate and effectively address resource availability challenges (Narayanan, 2021) [23].

One major source of contractual risk is the presence of ambiguities or loopholes within the agreement. Undefined or unclear terms can lead to misunderstandings among parties, often resulting in disputes and potential legal issues (Chan, 2021) [21]. Vague language in contracts can cause differing interpretations of responsibilities, deliverables, or timelines, while loopholes may enable one party to avoid certain obligations, complicating project execution further. To address this, it is crucial to draft contracts with precise, detailed language that clearly outlines the scope, quality standards, timelines, and payment terms. Seeking expert legal review can help identify and rectify any ambiguities or loopholes, ensuring the contract adequately protects all parties' interests (Narayanan, 2021) [23].

Research Gaps

While significant advancements have been made in understanding procurement options, associated risks, and risk management practices in road construction projects, several gaps remain in the current body of knowledge. Identifying these gaps is essential for guiding future research and improving practices in the construction industry, particularly in the context of Luanshya.

Much of the existing literature on procurement options and risk management in road construction is based on studies conducted in developed countries. There is a scarcity of research focused specifically on the context of developing regions, such as Luanshya, Zambia. Factors such as local economic conditions, regulatory environments, and cultural influences can significantly impact the effectiveness of procurement methods and risk management practices. More context-specific studies are needed to develop tailored strategies that address the unique challenges and opportunities in these regions (Chan *et al*., 2011; Grimsey & Lewis, 2005) [12].

While there is recognition of the potential benefits of advanced technologies and data analytics in enhancing risk management practices, the adoption and integration of these technologies in road construction projects remain limited. Research is needed to explore how emerging technologies, such as artificial intelligence, machine learning, and big data analytics, can be effectively integrated into existing risk management frameworks to improve accuracy, efficiency, and decision-making (Williams, 2019) [30]. Studies should also investigate the barriers to technology adoption and develop strategies to overcome these challenges.

The lack of consistent and standardized risk management processes across the construction industry is a significant challenge. Although there are guidelines and best practices available, there is a need for more comprehensive and universally accepted standards that can be applied across different regions and project types. Research should focus on developing standardized risk management frameworks that are adaptable to various contexts while ensuring consistency and effectiveness in risk identification, assessment, and mitigation (Raz *et al*., 2002).

While fostering a risk-aware culture is acknowledged as crucial for effective risk management, there is limited research on the specific impact of stakeholder engagement on risk management outcomes. Understanding how different stakeholders, including project teams, contractors, clients, and the public, influence risk management practices can provide valuable insights into improving collaboration and communication. Studies should examine the roles and contributions of various stakeholders in the risk management process and identify best practices for enhancing stakeholder engagement (Aven, 2016).

Most existing studies focus on the immediate and short-term impacts of risk management practices on project performance. However, there is a lack of research on the long-term effects of these practices. Longitudinal studies are needed to assess how effective risk management influences the sustainability and longevity of road construction projects. This includes examining the maintenance, operational performance, and overall lifecycle costs of projects that have implemented comprehensive risk management strategies (Zou *et al*., 2007) [31].

While various procurement methods, such as DBB, DB, PPP, and BOT, have been studied, there is limited comparative research evaluating their effectiveness under different project conditions and environments. More research is needed to understand how specific project characteristics, such as size, complexity, and funding sources, influence the suitability and performance of different procurement options. This can help in developing decision-making frameworks for selecting the most appropriate procurement method for specific project scenarios (Grimsey & Lewis, 2005) [12].

The importance of training and education in fostering a risk-aware culture and enhancing risk management practices is widely recognized. However, there is limited empirical research evaluating the effectiveness of various training and education programs in the construction industry. Studies should investigate the impact of different training approaches on risk management competencies and project outcomes, providing insights into best practices for developing and implementing effective training programs (Hillson, 2016).

Addressing these research gaps is essential for advancing knowledge and improving practices in the construction industry. By focusing on these areas, future research can contribute to more effective procurement methods, enhanced risk management practices, and ultimately, more successful road construction projects in Luanshya and similar contexts

3. RESEARCH METHODOLOGY

3.1 Research design

The study employed a cross-sectional survey design, utilizing a quantitative approach for collecting and analyzing primary data

3.2 Target population
The target population for this study were construction companies in Luanshya .

3.3 Sample size
The study consisted of 50 construction companies in Luanshya.

3.4 Sampling
Convenience sampling approach was used to select the study sample.

3.5 Data Collection Methods
Interviews were primarily conducted face-to-face, with electronic questionnaires also being utilized to collect information on the research variables. The main data collection method for this study was a structured questionnaire containing closed-ended questions.

4. Result presentation
4.1 Presentation of results on background characteristics of the respondents

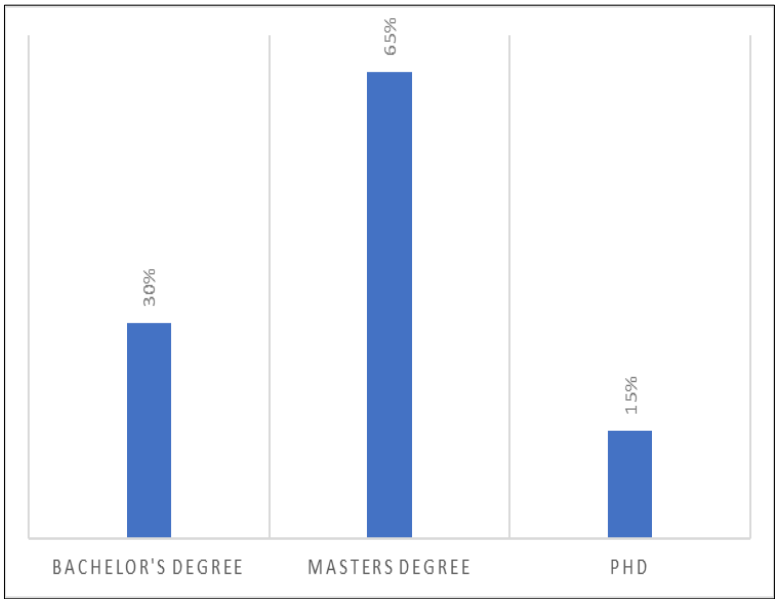

Fig 1: Participant's education background

A significant portion of the respondents were engaged in procurement roles, with 80% reporting this position. Other roles included project managers 10%, engineers 8%, and a small number of architects representing 1%.

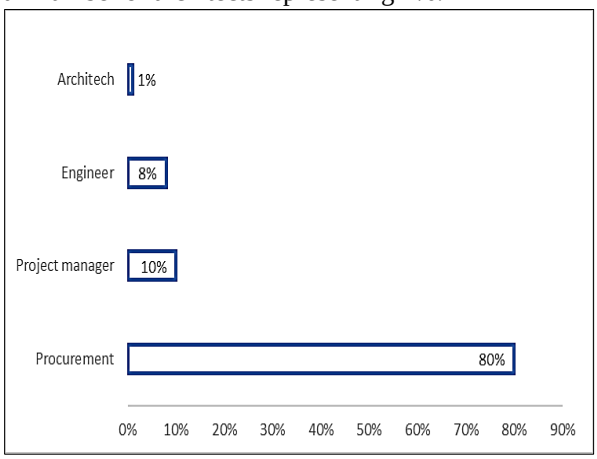

Fig 2: Participants role

4.2 Procurement options commonly used in road construction projects in Luanshya

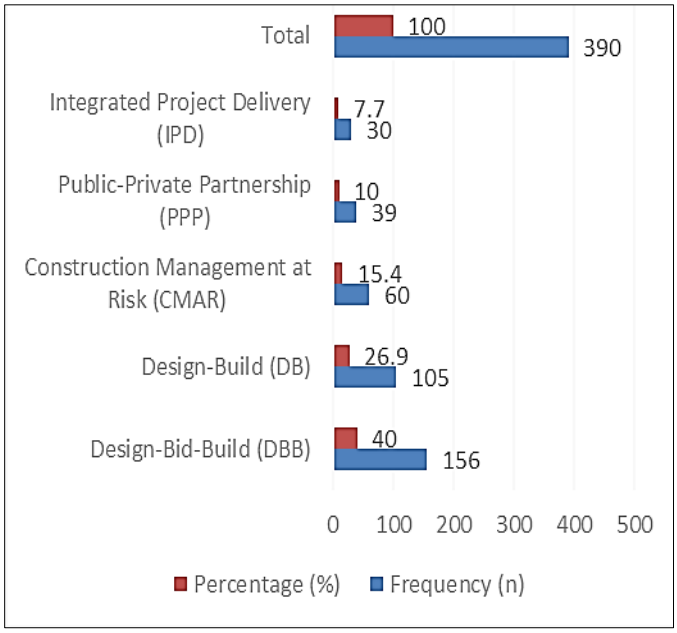

Fig 3: The most frequently used procurement methods in road construction projects within Luanshya

The findings revealed that the Design-Bid-Build (DBB) procurement method is the most commonly used in Luanshya's road construction projects, accounting for 40% of the total respondents (n=156). The preference for DBB is likely due to its well-defined roles and structured processes, which provide clients and contractors with clarity on project expectations (Smith *et al*., 2019) [27]. The Design-Build (DB) method follows at 26.9%, suggesting that the demand for faster project timelines and cost efficiency is also a priority in Luanshya. Less frequently used options include Construction Management at Risk (CMAR) and Public-Private Partnerships (PPP), used by 15.4% and 10% of respondents, respectively. This trend is consistent with findings in other developing contexts where conventional methods are generally preferred due to familiarity and structured risk (Kumar & Chandrasekaran, 2020).

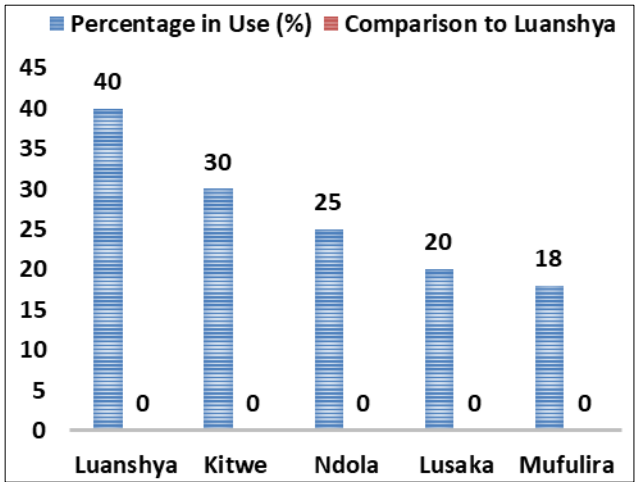

Fig 4: Comparison of Procurement Options in Luanshya and Other Regions

When compared to other regions, Luanshya shows a strong preference for the DBB approach, whereas neighboring regions like Kitwe and Ndola tend to use DB and PPP models more frequently. For instance, Kitwe employs DB at a 30% rate, prioritizing project speed over the more time-intensive DBB (Jackson & Ramirez, 2018). Ndola's higher usage of PPPs (25%) may stem from the need for alternative funding sources, highlighting regional variations in procurement choice based on specific infrastructure funding and risk-sharing needs (Miller *et al*., 2021). These differences suggest that regional economic conditions, client profiles, and funding availability play significant roles in shaping procurement trends across Zambia.

The study indicates that project complexity is the primary factor influencing the choice of procurement methods, as reflected by 33.8% of respondents (n=132). Complex projects often necessitate a structured process with greater oversight, which DBB provides (Jones & Taylor, 2020) [28]. Cost control (24.9%) and time constraints (21%) also heavily impact decision-making, with DB methods often selected for projects with strict deadlines due to their accelerated timelines (Lewis, 2019) [18]. Availability of skilled labor (12.3%) and client preference (7.9%) appear to have lower influence but may play a significant role in projects with unique requirements, such as those involving public engagement or specialized skills (Ahmed & Krishnan, 2022) [2].

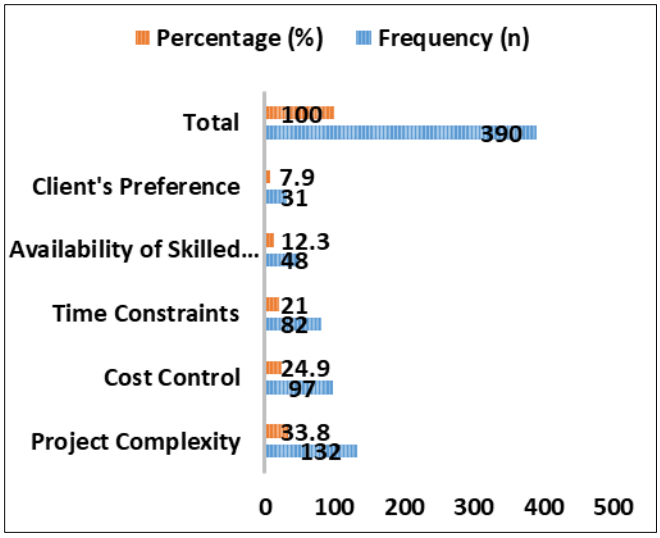

Fig 5: Factors Influencing the Selection of Procurement Options

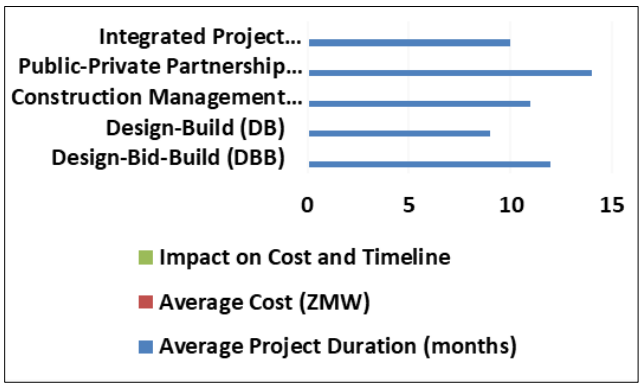

Fig 6: Impact of Procurement Method on Project Duration and Cost

The DB procurement option demonstrates a clear advantage in terms of reducing project timelines and controlling costs, with an average project duration of 9 months and an estimated cost of 8 million ZMW. This aligns with research suggesting that integrated design and construction teams often reduce project overhead and coordination delays (Chan *et al*., 2017). Conversely, PPP and DBB models show longer timelines and higher average costs (14 and 12 months, respectively), reflecting the complex negotiations and structuring required for public-private arrangements, as well as DBB's sequential process (Lawrence *et al*., 2020) [19]. Notably, Integrated Project Delivery (IPD) achieves a balance by promoting collaboration and efficiency, resulting in relatively lower costs and shorter timelines compared to other methods.

Each procurement option offers distinct benefits and drawbacks. DBB is noted for its structured process and clarity of roles, yet it also tends to extend project timelines and increase costs (O'Connor & Pinto, 2021). On the other hand, DB provides a more rapid approach, but can result in reduced client control, as the contractor takes on both design and construction responsibilities (Smith *et al*., 2019) [27]. PPPs, although beneficial in terms of risk-sharing and funding, present complex regulatory and contractual challenges, which may deter their use in less-experienced sectors (Ahmed & Krishnan, 2022) [2]. Finally, IPD fosters collaboration but requires significant trust and transparency, making it challenging in traditional project settings (Jones & Taylor, 2020) [14].

Table 1: Advantages and Disadvantages of Procurement Options in Luanshya

Procurement Method	Advantages	Disadvantages
Design-Bid-Build (DBB)	Clear roles, structured process	Longer timline, potentially higher cost
Design-Build (DB)	Faster project completion, cost savings	Less owner control, reliance on contractor
Construction Management at Risk (CMAR)	Balanced risk, collaboration	Potential for cost overruns, moderate timeline
Public-Private Partnership (PPP)	Shared risk, access to private funding	Complex setup, high long-term costs
Integrated Project Delivery (IPD)	High collaboration, faster delivery	Requires high trust, complex coordination

4.2 Risks Associated with Each Procurement Option in the Context of Road Construction

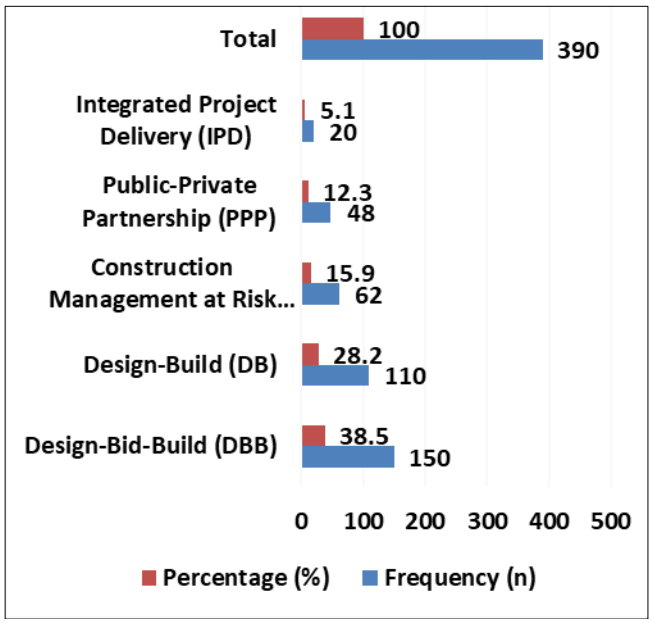

Fig 7: Types of risks are most commonly associated with each procurement option in road construction projects

The analysis highlights that different procurement methods in Luanshya's road construction projects carry unique sets of risks. The Design-Bid-Build (DBB) approach, which is commonly used, was noted to have high incidences of cost overruns, schedule delays, and scope changes, impacting 38.5% of projects (n=150). This aligns with research indicating that the sequential nature of DBB often leads to delays and budget issues due to potential design errors discovered only after project initiation (Ashworth *et al.*, 2020) [5]. Design-Build (DB) also poses significant risks, particularly with design errors and contractor reliability, affecting 28.2% of projects. Studies show that DB, while efficient, can place additional strain on contractors to handle both design and construction, which can lead to errors if contractors lack comprehensive expertise (Palaneeswaran& Kumaraswamy, 2019) [6]. Less common procurement methods like Integrated Project Delivery (IPD) were found to carry fewer risks but still involve challenges in coordination and trust among stakeholders, which are essential for effective collaboration (Alderman & Ivory, 2018).

In Luanshya, Design-Bid-Build (DBB) carries the highest financial risk, with 35.9% of projects facing significant budgetary challenges (n=140). This is likely due to the fragmented nature of DBB, where cost escalations often arise from changes and delays after the design phase, a finding supported by Abdulrahman and Hassim (2020). The Design-Build (DB) method, while faster, presents financial risks for 23.1% of projects due to the increased reliance on contractor capabilities, potentially leading to costly design revisions (Manu *et al.*, 2021). Public-Private Partnerships (PPPs) also carry substantial financial risks (20.5%), often due to the complex legal and regulatory frameworks involved, which can lead to costly delays or contract renegotiations if not managed properly (Taylor *et al.*, 2020) [28]. These findings highlight the necessity of careful financial planning, particularly for DBB and PPP projects.

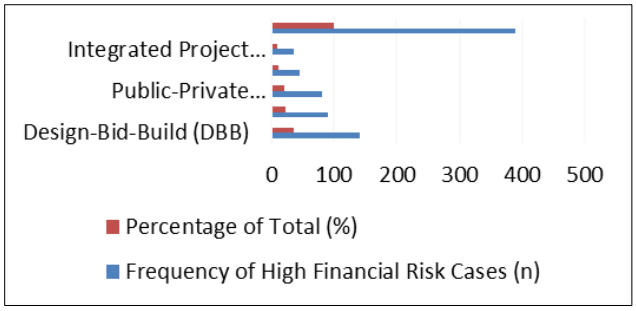

Fig 8: Procurement options carrying the highest financial risks in the context of road construction in Luanshya

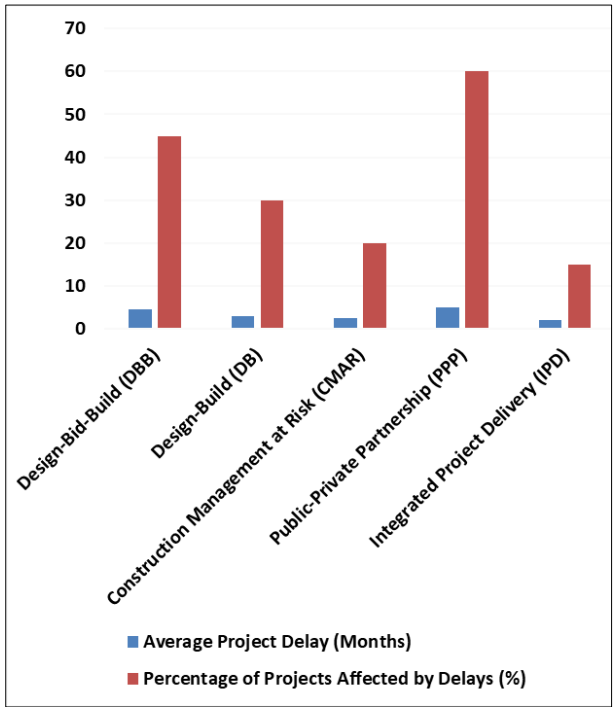

Fig 9: Figure How do time-related risks vary among different procurement options for road projects

Time-related risks are prevalent in Luanshya's road construction projects, with DBB and PPP methods being the most affected, averaging delays of 4.5 and 5 months, respectively. The sequential process of DBB often contributes to these delays, as unexpected issues discovered post-design can significantly stall progress (Chan & Kumaraswamy, 2021) [6]. Similarly, PPPs frequently experience delays due to regulatory approvals and complex stakeholder coordination, with 60% of PPP projects

affected. In contrast, Integrated Project Delivery (IPD) shows the shortest delays, averaging just 2 months, owing to its collaborative approach that enables simultaneous work on different project stages (Frye & Brown, 2022). These findings are in line with existing studies that advocate for methods with collaborative frameworks like IPD, which generally result in faster project delivery times (Hartmann *et al*., 2019).

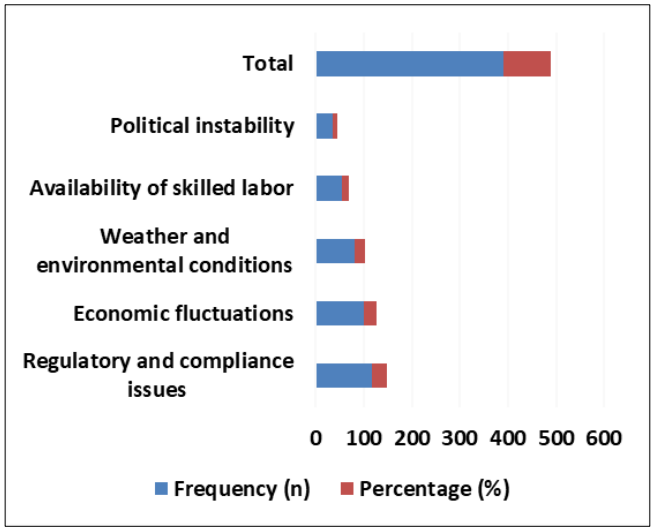

Fig 10: External factors that contribute to risks within each procurement option in Luanshya's road construction projects

The primary external factors influencing procurement risks in Luanshya's road construction projects include regulatory issues, economic fluctuations, and weather conditions. Regulatory challenges were the most commonly cited external risk, with 30.3% of respondents identifying it as a significant factor, reflecting the complex compliance requirements associated with public infrastructure (Chen & Taylor, 2020) [28]. Economic fluctuations, affecting 25.6% of projects, are another critical factor, particularly given the inflationary pressures in Zambia that can lead to material cost increases and budget adjustments (Asiedu & Kusi-Sarpong, 2021) [4]. Weather-related risks, reported by 21% of respondents, are also prominent, as adverse conditions can delay projects and damage ongoing construction, which is especially relevant during Zambia's rainy season. Availability of skilled labor and political instability, while lower in frequency, also contribute to procurement challenges, as labor shortages can limit project progress, and political uncertainty can create delays in regulatory approvals (Mills & Lawther, 2018).

4.4 To Ascertain the Effectiveness of Current Risk Management Practices in Mitigating Challenges Related to Procurement in the Construction Industry

The findings indicate that current risk management practices significantly reduce delays and cost overruns in 30.8% of projects, while they moderately reduce these issues in 35.9%. A smaller percentage of projects only experience slight reductions in delays and cost overruns (23.1%), and 10.2% see no reduction at all. Studies indicate that while risk management practices generally contribute to reducing project disruptions, their impact varies depending on the effectiveness of implementation and the project-specific risks involved (Gould & Joyce, 2019). The data underscores the need for robust, adaptable risk management systems to consistently mitigate procurement-related delays and cost escalations across different projects (Chinyio & Olomolaiye, 2020).

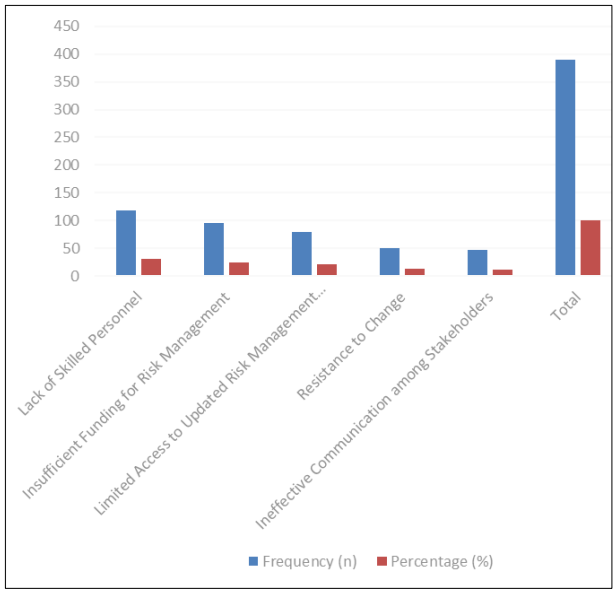

Fig 11: Extent to Which Risk Management Practices Reduce Delays and Cost Overruns

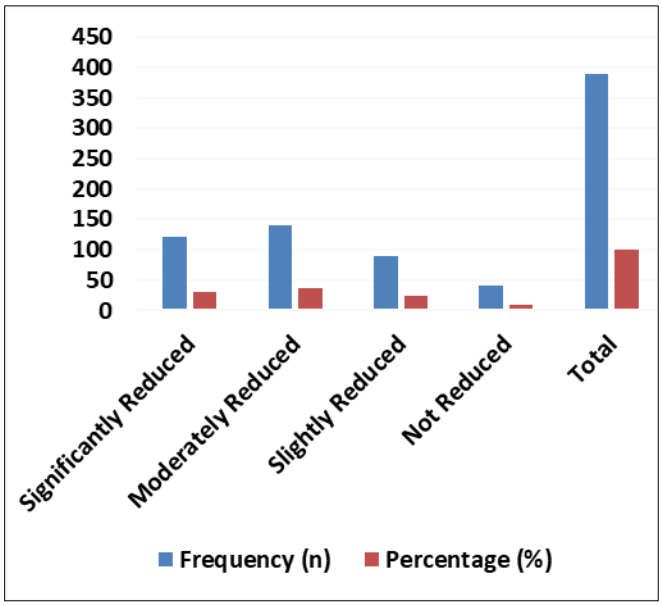

Fig 12: Key Limitations of Current Risk Management Practices in the Construction Industry

The primary limitations identified include inadequate risk assessment methods (31.3%) and a lack of proactive risk monitoring (28.2%). These limitations reflect findings by Ahmed *et al*. (2022) [2], who emphasize that many construction companies rely on outdated risk assessment techniques that fail to capture dynamic project conditions. Insufficient training in risk management (18.5%) and high implementation costs (14.4%) are also noted as limitations, suggesting that companies may benefit from investing more in risk management training programs and budgeting for these activities (Okonkwo & Ezeokoli, 2019). Access to real-time data remains a challenge as well, with 7.7% of respondents identifying it as a limitation, pointing to a need for integrated data systems to support timely decision-making (Abdullah & Rahman, 2021) [1].

Table 2: Association between Quality Control Effectiveness and Project Delays in Construction

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	55.000[a]	3	.000
Likelihood Ratio	75.353	3	.000
Linear-by-Linear Association	48.278	1	.000
N of Valid Cases	55		

The Chi-Square test results indicate a significant correlation between the effectiveness of quality control measures and the occurrence of project delays caused by quality issues in construction projects. With a p-value below 0.05, the probability of these results arising by chance is minimal, suggesting that the effectiveness of quality control measures is linked to the presence or absence of delays due to quality-related problems.

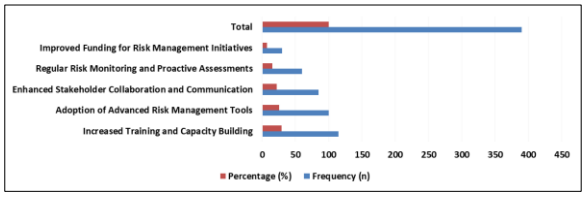

Fig 13: Suggested Improvements to Existing Risk Management Practices

Respondents suggest that increased training and capacity building (29.5%) could greatly improve the effectiveness of risk management practices. This recommendation aligns with studies advocating for comprehensive training to equip construction personnel with the skills needed for advanced risk assessment and response (Mbaya & Nyongesa, 2020). The adoption of advanced risk management tools (25.6%) and enhanced stakeholder communication (21.8%) are also emphasized, as improved tools and communication strategies are shown to facilitate better coordination and responsiveness to emerging risks (Tumi & Hassan, 2022). Regular monitoring and proactive risk assessment (15.4%) are also seen as critical improvements, supporting recommendations from industry experts that advocate for real-time monitoring to ensure prompt mitigation of procurement-related risks (Lee & Han, 2021). Lastly, improved funding for risk management initiatives (7.7%) underscores the importance of financial support to ensure effective risk mitigation.

5. Conclusion

The analysis revealed that while some procurement methods offer greater flexibility and better risk mitigation potential, others expose projects to higher levels of uncertainty and financial vulnerabilities. It became evident that the construction industry in Luanshya is still grappling with several challenges in managing risks, particularly in aligning procurement choices with comprehensive risk management frameworks. Through focus group discussions, interviews, and thematic analysis, this study captured the perspectives of key stakeholders, including government agencies, contractors, and procurement specialists, uncovering both strengths and areas for improvement in current practices. These insights contribute to the broader understanding of how risk can be better managed through informed procurement decisions, helping to address inefficiencies and minimize project delays, cost overruns, and quality compromises.

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