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Examining the Effectiveness of Cost Management Processes in Project Management: A Case Study of the Lusaka-Ndola Dual Carriageway

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Abstract

This study sought to examine the effectiveness of cost management processes in project management, using the Lusaka-Ndola Dual Carriageway as a case study. The general objective of this research is to assess how cost management strategies and practices influence the financial performance and delivery of infrastructure projects. Specifically, the study aims to: (i) establish the types of cost management systems and tools used in the Lusaka-Ndola Dual Carriageway project; (ii) analyze the effectiveness of the current cost management processes in controlling project expenditures and ensuring value for money; and (iii) ascertain the limitations and challenges faced in implementing efficient cost management mechanisms in the project. The study adopted a case study exploratory design, employing a mixed-methods approach to capture both quantitative and qualitative data. Primary data were collected from project managers, financial controllers, engineers, and procurement officers involved in the Lusaka-Ndola Dual Carriageway project through structured questionnaires and in-depth interviews. Quantitative data were entered and analyzed using STATA, applying descriptive statistics such as frequencies, percentages, and means to summarize the findings. Chi-square tests were conducted to examine associations between cost management practices and project performance. Qualitative data from interviews were analyzed thematically to identify key patterns, challenges, and insights. The study findings show that cost management in the Lusaka–Ndola Dual Carriageway Project relies heavily on traditional methods supported by gradual digital adoption. The unit rate method was the most applied cost estimation technique (40%), while bottom-up budgeting dominated (35%), indicating participatory financial planning. A hybrid cost control system (40%) and widespread use of MS Excel (50%) demonstrate a transition toward digital tools, though specialized software remains underused. Bills of Quantities (50%) served as the main basis for cost planning, while quantity surveyors (45%) were the primary cost managers, confirming technical dominance in project control. A significant relationship ($\chi^2 = 96.667$, $p = 0.000$) between budget revision frequency and cost alignment suggests that frequent reforecasting improves financial accuracy. However, limitations persist, including lack of digital systems (35%), poor documentation (35%), and material price instability (35%), which hinder data accuracy and cost control. Chi-square tests confirmed significant links between cost data accuracy and cost tool limitations ($p = 0.001$), and between cost overruns and budget variance sources ($p = 0.001$), showing interdependence between management processes. Institutional barriers such as weak policy frameworks (30%) and bureaucratic approvals (25%) further constrain efficiency, emphasizing the need for stronger digital integration, policy reform, and capacity building in cost management for large infrastructure projects. The Lusaka–Ndola Dual Carriageway Project applies structured cost management combining traditional methods like unit rate and bottom-up budgeting with emerging digital tools, though hybrid systems and MS Excel indicate partial modernization. Cost estimates largely aligned with actual expenditures, but material price fluctuations and design changes contributed to overruns, and integration with scheduling was limited. Key challenges included inadequate digital infrastructure, inconsistent data, limited skilled personnel, and institutional inefficiencies, affecting cost control and reporting. The study recommends enhanced digital adoption, staff training, improved data integration, contingency planning, and stronger institutional frameworks to achieve more effective and efficient cost management.

Keywords: Cost Management, Dual Carriageway, Road Development Agency (RDA)

1. Introduction

1.1 Background

Cost management is a critical component of project management that ensures projects are completed within approved budgets while achieving desired objectives (Hanioglu, 2022) [29]. It encompasses the processes of planning, estimating, budgeting, financing, funding, managing, and controlling costs to ensure that the project is completed within the approved financial framework (Venkataraman, 2023). Effective cost management is vital for infrastructure projects such as road construction, which typically require significant capital investment and are prone to cost overruns due to a variety of factors including poor

planning, inflation, inadequate risk management, and project delays (Tembo, 2024).

Globally, infrastructure projects have consistently faced cost management challenges. Notable studies from countries such as the United Kingdom, the United States, and Australia have documented that major infrastructure projects often exceed their initial budget estimates. For instance, Flyvbjerg (2021) [25] found that nine out of ten projects globally experience cost overruns, often due to optimism bias, strategic misrepresentation, and technical errors in estimation. In developing countries, including those in sub-Saharan Africa, the problem is exacerbated by limited technical capacity, corruption, weak regulatory environments, and inadequate project monitoring and evaluation frameworks (Appiah, 2022).

In the African context, road infrastructure remains a cornerstone of economic development. The African Union's Programme for Infrastructure Development in Africa (PIDA) highlights the need for efficient transport corridors to facilitate trade and regional integration (Raza, 2024). However, several road projects across the continent have suffered from financial mismanagement and overruns. Examples include Kenya's Standard Gauge Railway and Ghana's Eastern Corridor Road Project, both of which faced public criticism due to cost escalations and allegations of misappropriation (Gitari, 2019) [27].

In Zambia, road construction and rehabilitation form a key part of the country's development agenda, guided by policies such as the National Transport Policy and the Seventh and Eighth National Development Plans (Changala, 2024) [16]. The Road Development Agency (RDA), established under the Public Roads Act No. 12 of 2002, is tasked with managing the country's road infrastructure (Mutale, 2021). However, despite various reforms, Zambia's road projects have often faced scrutiny regarding financial management and cost effectiveness. The Lusaka-Ndola Highway, a critical transport corridor linking the capital city to the Copperbelt Province, has attracted significant attention due to controversies surrounding its budget estimates, procurement processes, and delays in execution (Zajontz, 2023).

The effectiveness of cost management processes directly influences the outcomes and sustainability of infrastructure projects. Ineffective cost control can result in project delays, increased financial burdens on the state, reduced public trust, and the failure to achieve intended economic and social benefits (Uddin, 2025). Conversely, robust cost management ensures optimal allocation of resources, timely project completion, and improved public service delivery (Catalão, 2022). This study, therefore, seeks to critically examine the effectiveness of cost management processes in project management, using the Lusaka-Ndola Highway as a case study. It aims to explore the factors influencing cost performance, assess the adequacy of existing cost control mechanisms, and provide evidence-based recommendations to enhance financial efficiency in similar future projects. Through this investigation, the study contributes to the broader discourse on public project governance and sustainable infrastructure development in Zambia and beyond.

1.2 Statement of the Problem

Cost management remains a major challenge in the execution of infrastructure projects in Zambia, particularly in large-scale road construction projects such as the Lusaka-Ndola Highway (Zajontz, 2023). Despite the existence of regulatory frameworks and public finance management policies, cost overruns, budget inflation, and financial mismanagement continue to undermine the effectiveness of project implementation (Musonda, 2023). These issues result in project delays, increased public expenditure, and reduced value for money, ultimately impacting national development goals. The Lusaka-Ndola Highway project, initially valued at over US$2 billion for a 321-kilometer stretch, raised widespread public and professional concerns regarding its cost effectiveness and transparency. According to the National Road Fund Agency, this budget translated to approximately US$4.1 million per kilometer, a figure significantly higher than the regional average of US$1 million to US$2 million per kilometer for similar road projects. The cost sparked public outcry and led to a government review and subsequent cancellation and renegotiation of the contract in 2023. However, even under the revised agreement pegged at approximately US$650 million, doubts remain regarding the adequacy of cost control mechanisms and the integrity of procurement processes (Lusaka Times, 2024). The problem is further compounded by the lack of empirical studies that assess the effectiveness of cost management processes in Zambia's infrastructure projects. Most available data focus on general financial irregularities, leaving a gap in understanding the practical implementation and enforcement of cost control mechanisms specific to project management. This gap limits the ability of policymakers and stakeholders to make informed decisions that could improve project delivery and financial accountability. Therefore, the prevailing problem is that cost management processes in road infrastructure projects in Zambia are ineffective, as evidenced by recurring cost overruns, inflated budgets, and weak accountability mechanisms. The Lusaka-Ndola Highway serves as a high-profile example of these systemic issues. This study seeks to investigate the root causes and practical challenges of cost management in this project, with the aim of identifying gaps and recommending strategies for enhancing financial efficiency and transparency in future infrastructure developments.

1.3 Objectives of the Study

The general objective of this study is to examine the effectiveness of cost management processes in project management, with a specific focus on the Lusaka-Ndola Dual Carriageway project.

1.4 Specific objectives of the study

1. To Establish the types of cost management used in construction projects in the Lusaka-Ndola Dual Carriageway project.
2. Analyze effectiveness of current cost management processes in the Lusaka-Ndola Dual Carriageway project.
3. Ascertain limitations in cost maaangement processes in construction projects in the Lusaka-Ndola Dual Carriageway project.

1.5 Research Questions

1. What types of cost management practices are used in the Lusaka-Ndola Dual Carriageway construction project?

2. How effective are the current cost management processes in the Lusaka-Ndola Dual Carriageway construction project?
3. What are the limitations of cost management processes in the Lusaka-Ndola Dual Carriageway construction project?

1.6 Theoretical Framework

The conceptual framework for this study is designed to evaluate cost management practices in the Lusaka-Ndola Dual Carriageway project by examining three key components: the types of cost management techniques used, the effectiveness of these processes, and the limitations encountered. The first component focuses on identifying the various cost management methods applied within the project, such as budgeting, cost estimation, forecasting, and cost control mechanisms. Understanding these practices provides a foundation for analyzing their role in managing project expenditures (Venkataraman, 2023).

The second component addresses the effectiveness of the current cost management processes. This involves assessing how well these techniques help achieve cost-related goals, including maintaining the project within budget, minimizing cost overruns, and ensuring financial efficiency. The third component explores the limitations or challenges affecting cost management efforts. These may include internal constraints like poor planning and resource shortages, as well as external factors such as inflation, delays, regulatory issues, and corruption (Tembo, 2022).

Together, these variables influence the dependent variable the overall cost performance of the Lusaka-Ndola Dual Carriageway project. This refers to how successfully the project is managed in financial terms, particularly in adhering to cost plans and achieving value for money. Additionally, the framework considers possible moderating variables such as stakeholder involvement, project complexity, and the policy and regulatory environment, all of which can impact the effectiveness and outcomes of cost management practices. This integrated approach offers a structured basis for understanding how different elements of cost management contribute to project success or failure.

2. Literature Review

2.1 Types of cost management used in construction projects

One of the most commonly used and effective cost budgeting strategies in road construction projects is the Work Breakdown Structure (WBS)-based budgeting approach. A WBS is a hierarchical decomposition of the overall scope of a project into smaller, more manageable components or deliverables (Uddin, 2025). This structured framework allows project managers to break down large and complex construction tasks into smaller, task-specific work packages. In the context of a road project such as the Lusaka-Ndola Dual Carriageway, the WBS includes components such as site clearance, earthworks, drainage systems, sub-base and base layers, asphalt surfacing, bridge construction, toll plaza installations, road markings, signage, and landscaping (Iheanacho, 2023). Each of these components is treated as a distinct work package, making it easier to assign specific budgets, allocate resources, and monitor progress and cost performance throughout the project lifecycle (Akbar, 2024) [3].

In Zambia, where infrastructure development has gained momentum through initiatives like Link Zambia 8000, the use of structured budgeting approaches such as WBS has become increasingly relevant (Musonda, 2023). These projects are often scrutinized by stakeholders such as the Road Development Agency (RDA), the Ministry of Infrastructure, and external financial institutions. The Lusaka-Ndola Dual Carriageway, given its national economic importance and public visibility, requires robust cost management strategies to avoid the cost overruns and misallocations that have plagued similar projects in the past (Mukulula, 2020). WBS-based budgeting enables detailed cost forecasting for each construction stage, from initial mobilization and procurement to final inspection and commissioning. It also allows the integration of contingency allocations within each work package to account for unforeseen risks, such as adverse weather conditions, delays in material delivery, or fluctuations in foreign exchange rates that affect imported construction inputs (Cerezo, 2020).

Historical cost estimation is a widely adopted strategy in road construction project budgeting, particularly in environments where current market data is unreliable or not readily accessible (Awuku, 2024). This method involves using financial data and cost outcomes from past, similar projects to project or forecast the likely costs of a new project. In essence, it assumes that the cost behavior of comparable road works can serve as a baseline or reference point for new budget estimates (Karaca, 2020). For the Lusaka-Ndola Dual Carriageway project in Zambia, historical cost estimation is a particularly valuable tool given the country's history of implementing large-scale road infrastructure projects. Notable examples include the Mongu-Kalabo road, the Great East Road upgrades, and the broader Link Zambia 8000 initiative—each of which provides detailed insights into cost patterns, procurement challenges, material sourcing expenses, labor costs, and other financial variables (Brautigam, 2021) [13].

Activity-Based Budgeting (ABB) is a modern and highly detailed cost management strategy that assigns financial resources to specific construction activities rather than grouping expenses under general departments or line items (Amin, 2021). This approach emphasizes budgeting based on the actual activities that drive costs within a project, making it especially valuable for large and complex infrastructure projects like the Lusaka-Ndola Dual Carriageway. Instead of allocating funds to broad categories such as "operations" or "materials," ABB divides the project into specific tasks such as site clearance, excavation, asphalt laying, culvert construction, bridge installation, pavement finishing, quality inspections, and even traffic management (Wang, 2024). Each of these activities is budgeted independently, based on its scope, resource needs, and projected timeline, allowing for a highly precise financial plan.

Unit Rate Estimation is a foundational budgeting strategy commonly employed in road construction projects, particularly in countries like Zambia where standardized construction norms and cost benchmarks are frequently used (Malipilo, 2023). This method involves calculating the cost of specific tasks or materials on a per-unit basis such as the cost per kilometer of asphalt paving, per cubic meter of concrete, or per linear meter of drainage pipes and then multiplying these rates by the estimated quantities required for the project (Pujitha, 2020). The resulting figures are used

to derive the overall budget. The effectiveness of this method lies in its simplicity, adaptability, and reliance on measurable units, which makes it especially useful for large-scale infrastructure projects (Elmousalami, 2020) [23].

Contingency Allowance Planning is a critical component of cost management in road construction projects, particularly those of large scale and complexity such as the Lusaka-Ndola Dual Carriageway (Akbar, 2024) [3]. This strategy involves setting aside a specific portion of the project budget typically ranging from 5% to 15% as a financial buffer to cover unexpected costs or risks that may arise during the course of the project. These allowances are not allocated to any particular activity at the outset but are instead reserved for unforeseen events that could disrupt the project timeline or budget (Chiputa, 2024). The essence of this approach lies in its proactive nature, recognizing the reality that no matter how meticulous the planning and estimation process may be, uncertainties and variances are inevitable in construction environments (Awuku, 2024).

In the Zambian context, the need for contingency allowance planning is especially pressing due to several local and regional factor (Goma, 2022) [28]. These materials are subject to international market price fluctuations and are paid for in foreign currency. Given the volatility of the Zambian Kwacha, any depreciation can lead to a significant increase in project costs. Without contingency planning, such currency-related shocks could stall or even derail the project. Additionally, the climatic and environmental unpredictability in Zambia necessitates contingency budgeting (Chiputa, 2022) [18]. The country experiences distinct wet and dry seasons, and unexpected shifts in rainfall patterns such as early onset of rains or prolonged wet seasons—can affect the progress of construction activities like earthworks, asphalt laying, and bridge foundation works. Delays caused by weather may also increase the cost of equipment hire, workforce salaries, and material storage, all of which can erode the base budget if no contingency has been factored in (Galea, 2024) [26].

2.2 Current cost management processes in road project.

Effective cost monitoring is a critical component of road construction project management, especially in large-scale infrastructure ventures such as the Lusaka-Ndola Dual Carriageway (Mushori, 2020). These mechanisms are designed to track actual spending against budgeted costs, detect deviations early, and implement corrective actions to keep the project within financial boundaries. In Zambia and globally, a variety of cost monitoring mechanisms are applied throughout the implementation phase to ensure financial discipline, transparency, and accountability.

One of the fundamental tools used in cost monitoring for road construction projects is the Earned Value Management (EVM) system (Hasan, 2021). EVM is a project management methodology that provides a comprehensive and objective approach to measuring project performance by integrating three key variables: scope, time, and cost (Balali, 2020). This system allows project managers and stakeholders to assess how much work has been accomplished in relation to the budgeted amount and the timeline set for the project. In large-scale infrastructure projects EVM is particularly beneficial because it offers a structured framework for tracking financial and physical progress concurrently (Bahrudin, 2025).

In Zambia, where infrastructure projects like the Lusaka-Ndola Dual Carriageway are often co-funded by the government and international financiers or PPP, the use of EVM provides a transparent mechanism for reporting and accountability (Mushori, 2020). Development partners and oversight institutions such as the Road Development Agency (RDA), Ministry of Infrastructure, and Office of the Auditor General can use EVM reports to assess project health and ensure compliance with financial regulations and targets. Furthermore, the system supports performance-based contracting, where contractors' payments and incentives are tied to actual progress measured against planned outcomes (Ahmed, 2020) [2]. Additionally, EVM fosters better communication among stakeholders by providing clear, data-driven insights into project status. Regular EVM reports and dashboards can be shared with project sponsors, government bodies, and the public, thereby enhancing confidence and minimizing suspicion of mismanagement.

Another widely used cost monitoring mechanism in road construction projects is the Cost Control Ledger or Budget Tracking Sheet. These tools are essential for tracking and managing project expenditures in a detailed and systematic manner (Aguocha, 2023) [1]. Typically implemented as spreadsheets or specialized software systems, they enable real-time or periodic updates of every expense item against the approved budget. By documenting actual costs incurred across different components of a project such as procurement of materials, labor charges, equipment rental, subcontractor payments, and administrative costs the ledger helps ensure that spending remains aligned with financial plans (Tariq, 2020).

In Zambia, institutions like the Road Development Agency (RDA) have institutionalized the use of standardized cost control tools across national road infrastructure projects (Appiah, 2022). The RDA provides templates that outline expenditure categories, cost codes, and reporting formats, which must be followed by contractors and consultants. This standardization is crucial for facilitating oversight and audits, especially when multiple stakeholders including government ministries, international donors, and private investors are involved (Changala, 2024) [16]. Uniform cost tracking mechanisms make it easier for external auditors and project monitors to verify compliance, detect financial mismanagement, and recommend improvements.

The use of digital solutions for budget tracking is also increasing. Many contractors now use project management software that integrates financial tracking with scheduling, procurement, and resource management (Hanioglu, 2022) [29]. These systems can generate automated reports and dashboards that provide real-time insights into budget status, cost-to-completion, and projected overruns. This enhances not only efficiency but also accuracy, reducing the risk of human error associated with manual entries. Additionally, digital systems can set alerts for thresholds and variances, ensuring that financial issues are flagged as soon as they arise (Catalao, 2022).

Progress billing and contractor payment certifications are essential tools in the cost monitoring and control framework of road construction projects. These mechanisms ensure that payments to contractors are directly tied to the actual work completed, fostering transparency, accountability, and financial discipline (Tembo, 2024). Progress billing involves the contractor submitting periodic invoices based on the physical progress of the project, typically on a monthly or

milestone basis. These invoices, which detail the value of work completed up to that point, are reviewed and certified by supervising engineers or project managers (Raza, 2024). The value of work completed is often calculated as a percentage of the total project, based on clearly defined milestones or stages of construction. This process ensures that contractors are paid for the actual value of work performed, rather than for anticipated or uncompleted work, which minimizes the risk of budget overruns (Ullah, 2023).

Similarly, Microsoft Project (MS Project) is another popular tool that supports project managers in scheduling tasks, assigning resources, and monitoring budgets (Muthusamy, 2021). MS Project allows users to track costs at a granular level, making it easier to control budgets and stay on top of project expenses. MS Project can be particularly useful for creating cost baselines and tracking earned value management (EVM), allowing project managers to compare planned costs with actual costs and earned value. This comparison is critical in ensuring that the project remains within budget and on schedule (Ahmed, 2020) [2].

2.3 Limitations in cost maaangement processes in construction projects

Cost management processes in construction projects often face several limitations that hinder effective budget control and financial performance. These include inaccurate cost estimations due to poor initial planning and incomplete designs, inadequate budgeting that fails to account for inflation or unforeseen risks, and ineffective cost control mechanisms resulting from delayed reporting and lack of real-time monitoring tools (Tariq, 2020). Additional challenges include frequent scope changes, weak risk management practices, fragmented stakeholder communication, limited technical capacity among project teams, and minimal use of modern technology (Okere, 2020). In publicly funded projects, corruption and political interference further compromise cost efficiency. Collectively, these limitations contribute to cost overruns, delays, and reduced project quality, underscoring the need for stronger systems, transparent processes, and skilled management to enhance cost control in construction (Rao, 2022).

Cost overruns are a common challenge in road construction projects worldwide, and they can significantly impact the project's completion timeline, financial stability, and overall success (Akbar, 2024) [3]. Several factors contribute to cost overruns, which can vary from project to project, but the most common causes can be grouped into several broad categories. These include inaccurate cost estimation, scope changes, unforeseen site conditions, poor project management, inflation, labor-related issues, and ineffective procurement strategies (Brautigam, 2021) [13].

Inaccurate cost estimation is one of the primary contributors to cost overruns in road construction projects, particularly during the planning phase (Choi, 2023). A reliable and comprehensive cost estimate is crucial to the successful execution of any project, as it provides the foundation for financial planning and resource allocation. However, when cost estimations are flawed, it can set the stage for a cascade of issues that ultimately result in budget shortfalls and project delays (Awuku, 2024). One of the main reasons for inaccurate cost estimation is the lack of sufficient experience or data available during the early stages of a project. In road construction, many variables must be considered, including material costs, labor wages, equipment requirements, and potential contingencies (Akbar, 2024) [3]. If the initial estimates are based on incomplete or outdated data, they are likely to fail in accounting for the actual needs of the project (Chiputa, 2022) [18].

Changes in government policies and regulations can also prompt scope alterations. In many road construction projects, particularly those funded by public or donor money, changes in government policy or safety regulations can influence the project's requirements (Dasqupta, 2023). If the government enacts new environmental standards, or if there are last-minute shifts in policy regarding road safety or accessibility, contractors may be required to implement additional features or modifications, such as new drainage systems, pedestrian walkways, or traffic control measures. Such alterations can lead to unexpected increases in material, labor, and equipment costs (Hidalgo, 2024) [31].

Stakeholder demands or requests for changes can also contribute to scope creep. During the construction of a road, stakeholders including government officials, local communities, and contractors may request modifications to the original plan (Goma, 2022) [28]. These requests could involve adding new road features, enhancing the project's aesthetic qualities, or addressing additional transportation needs. For example, local authorities may decide to add new toll booths, interchanges, or bridges mid-project, which would necessitate additional planning, design, and construction efforts, all of which incur extra costs (Choi, 2023).

In Zambia, road construction projects often rely heavily on imports for critical materials, and the price of these imports can fluctuate rapidly (Fayomi, 2023). Similarly, steel prices may rise if there is an increase in demand from the global construction industry, as seen in periods of rapid economic growth in other parts of the world. Such price fluctuations can cause delays as procurement teams struggle to secure the necessary materials at the projected costs, which then pushes the budget higher (Fayomi, 2023).

The unpredictability of these price fluctuations presents a major challenge for project planners and managers. While inflation and market volatility are common occurrences, their timing and magnitude are often difficult to predict (Hanioglu, 2022) [29]. This uncertainty makes it difficult to accurately estimate the total cost of a project during the planning phase. Although contingency funds may be allocated to absorb some unforeseen costs, the volatility of material prices and exchange rates can often exceed what was anticipated, leading to significant budget shortfalls (Appiah, 2022).

Furthermore, even when inflation and price fluctuations are anticipated, managing them during the execution phase remains a challenge (Ahmed, 2020) [2]. Project managers must continuously monitor market trends and adjust their procurement strategies accordingly. They must also engage in proactive contract management to ensure that prices are locked in whenever possible, or that escalation clauses are included in contracts to address price increases (Balali, 2020). However, in the absence of such measures, road construction projects can quickly exceed their budgetary limits due to rising material costs (Ali, 2024) [4].

2.4 Research Gaps

Despite the growing body of literature on procurement inefficiencies and their implications for project performance, there remains a significant gap when it comes to context-specific research focused on Zambia, particularly in large-scale infrastructure projects like the Lusaka-Ndola Dual Carriageway. Much of the existing research provides generalized insights into common procurement challenges, such as lack of competitive bidding, unreliable suppliers, and contract mismanagement, primarily using international case studies or theoretical frameworks. While these discussions are valuable, they often fail to consider the socio-economic, political, and institutional nuances that shape project implementation in Zambia.

Infrastructure development in Zambia is influenced by unique factors such as local procurement laws, limited capacity in regulatory institutions, and political involvement in large projects. These realities necessitate a more localized analysis. The Lusaka-Ndola Dual Carriageway, as one of the most high-profile road projects in the country, presents an ideal case to evaluate how cost management practices are applied in real-world conditions. However, empirical data on how costs were planned, managed, controlled, and reported throughout its project lifecycle is currently limited. Without such context-specific evidence, policy-makers, project managers, and stakeholders are left without a clear roadmap for improving future projects.

A critical gap in the literature is the lack of thorough examination regarding the interaction between procurement-related challenges and the effectiveness of formal cost control mechanisms used in project management. While numerous studies underscore procurement inefficiencies such as non-competitive bidding, unreliable suppliers, poor contractor performance, and weak contract enforcement as key contributors to project delays and cost escalations, few delve into how these issues directly affect the functionality and reliability of formal cost control tools like Earned Value Management (EVM), variance analysis, or forecasting methods.

Formal cost control mechanisms are designed to monitor project performance, ensure alignment with budgets, and provide early warnings of potential cost overruns. However, their effectiveness is highly dependent on the stability and predictability of project inputs such as timely procurement of materials, reliable supplier performance, and consistent scope execution. When procurement systems break down, the accuracy of data feeding into cost control systems becomes compromised. For instance, unreliable suppliers can cause delays or force the use of substitute materials, which may not be accounted for in the original cost baseline, skewing EVM indicators and rendering variance analyses ineffective. Similarly, poor contractor performance can lead to rework, causing resource consumption patterns that deviate from planned expenditures, further distorting forecasting models.

A notable shortcoming in the existing body of research on cost management in large-scale infrastructure projects, particularly in the Zambian context, is the predominant reliance on secondary literature. Much of the current analysis is derived from general frameworks, international case studies, or global best practices, which, while valuable, often fail to reflect the unique economic, institutional, and socio-political conditions surrounding major local projects such as the Lusaka-Ndola Dual Carriageway. This overdependence on secondary sources limits the contextual relevance and applicability of the findings to Zambia's infrastructural realities.

Secondary literature often abstracts and generalizes experiences from multiple regions without considering localized variables such as regulatory frameworks, capacity of local contractors, resource availability, or the nuances of stakeholder engagement. As a result, such literature may provide only a partial understanding of the cost management dynamics that unfold on the ground. For instance, while corruption or poor procurement practices may be broadly recognized as cost drivers globally, the specific forms these issues take in Zambia such as political influence in contractor selection or delays due to decentralized financial approvals may remain underexplored.

3. Methods and Procedures

3.1 Research Design

A study design refers to a collection of tools and methods crafted for a particular purpose, detailing the reasoning and procedures for their application (Traacy, 2024). On the other hand, a research design acts as a systematic framework that directs the collection, analysis, and interpretation of data to effectively answer the research questions. Accordingly, this study utilized a cross-sectional case study design and applied a mixed-methods approach to gather primary data. This approach enabled the collection of data at one specific point in time, offering a thorough overview of the variables being examined (Amadi, 2023) [6].

3.2 Target Population

By definition, a population is defined as a collection of objects, events, or individuals sharing common characteristics that the researcher is interested in studying (Willie, 2024). The target population for this study will consist of project managers, architects, engineers at Macro Oceans Investment Consortium (MOIC-LN) involved in the construction of the Lusaka - Ndola dual carriageway.

3.3 Sampling Design

The study employed a convenience sampling technique, which is a non-probability sampling method where participants are selected based on their availability, accessibility, and proximity to the researcher (Pace, 2021). This approach involves the intentional selection of individuals or groups from the target population who meet predefined criteria relevant to the research objectives. It allows the researcher to gather data quickly and efficiently, particularly when time, resources, or access are limited.

Sample Size: A sample is a subset of a population that is used to represent the entire group. The sample size for this study consisted 100 participants.

3.4 Data Collection Method

The primary research tool used in the study was a semi-structured questionnaire, which included both closed-ended and open-ended questions. This design is particularly well-suited for mixed-method research, as it allows for the collection of both quantitative and qualitative data. Primary data was gathered using structured surveys, involving standardized questionnaires administered mainly through electronic platforms, with some face-to-face interviews conducted as needed. This approach enabled the researcher to collect comprehensive and relevant data on the study

variables efficiently (Mulisa, 2022).

3.5 Triangulation

The study employed triangulation as a research strategy to enhance the credibility and dependability of its findings (Bans, 2021). This approach involved combining various data sources, methods of data collection, and/or researchers' viewpoints to confirm and verify the results. In this case, triangulation was accomplished by gathering both quantitative and qualitative data through surveys. This method reduced the risk of bias and offered a more comprehensive and accurate perspective of the research subject, thereby strengthening the overall reliability of the study's conclusions.

3.6 Data Analysis

STATA was utilized for both data entry and statistical analysis, whereas Microsoft Excel 365 was employed to display descriptive statistics using graphical representations. For inferential analysis, the Chi-square test was conducted to examine associations between categorical variables (Kabir, 2022). Qualitative data were analyzed using thematic analysis, a method that involves systematically identifying, organizing, and interpreting recurring patterns or "themes" within the responses. This approach is especially valuable in mixed-methods research, as it provides in-depth insights and perspectives that enhance and complement the quantitative results (DeJonckheere, 2024).

4. Presentation of Findings

4.1 Presentation of results on background characteristics of the respondents

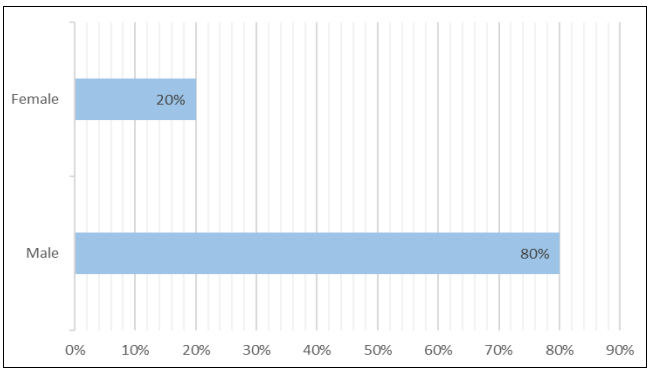

Fig 4.1.1: Participants' Gender

The study results show that the majority of participants were male, accounting for 80%, while female participants made up 20%.

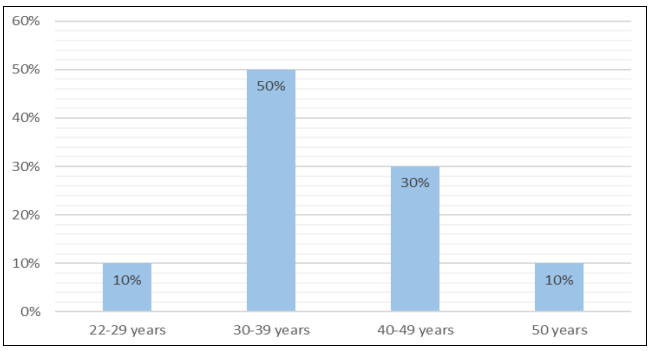

Fig 4.1.2: Participants' Age

The age distribution indicates that most participants were between 30–39 years (50%), followed by those aged 40–49 years (30%). Participants aged 22–29 years and 50 years and above each accounted for 10%.

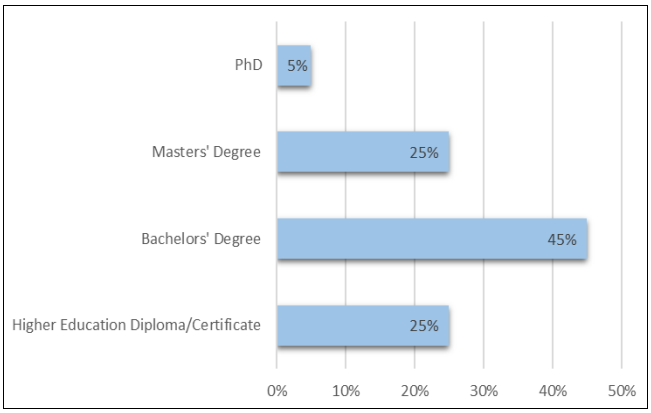

Fig 4.1.3: Highest level of education

The respondent pool is highly educated, with 75% holding a bachelor's degree or higher. This high education level indicates a capacity for understanding complex financial and strategic aspects of cost management. The findings therefore reflect informed opinions from qualified professionals in the field.

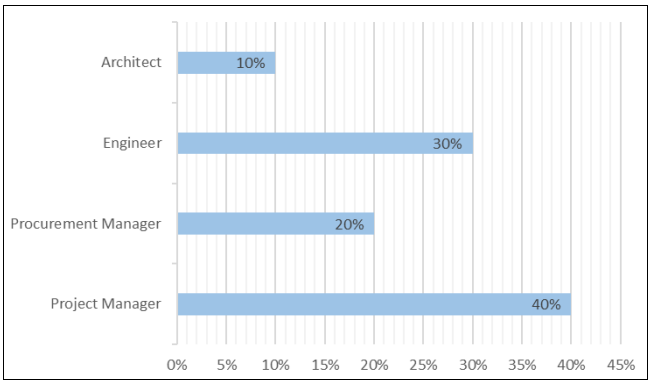

Fig 4.1.4: Professional Distribution of Respondents

Project Managers form the largest professional group among respondents (40%), indicating strong representation from those directly responsible for cost control. Engineers (30%) and Procurement Managers (20%) provide important technical and purchasing perspectives on cost management.

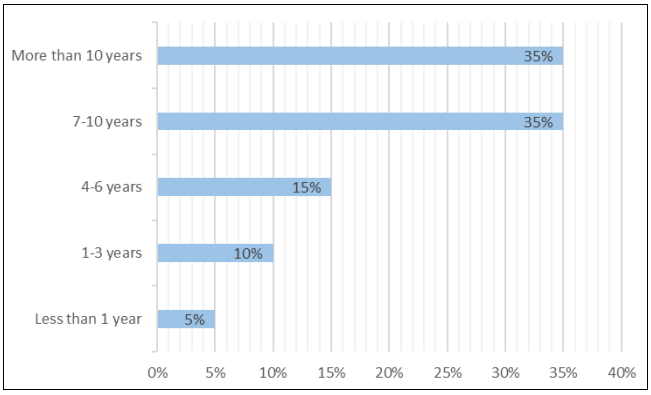

Fig 4.1.5: Respondents' Experience in Project Procurement

The data shows a highly experienced respondent pool, with 70% possessing more than 6 years of procurement experience. The average experience level is 8.4 years, indicating substantial familiarity with procurement processes and cost management challenges. This expertise level lends credibility to insights regarding procurement risks and budgeting strategies.

4.2 The types of cost management used in construction projects in the Lusaka-Ndola Dual Carriageway project.

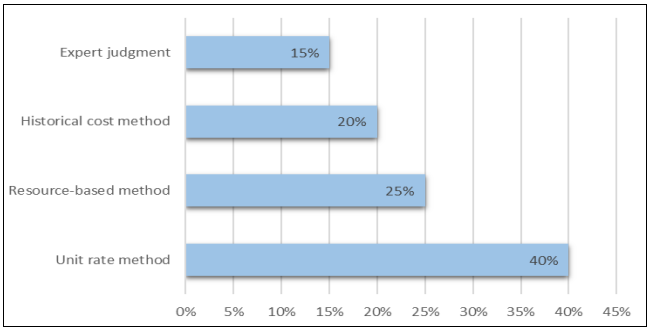

Fig 4.2.1: Cost estimation method

The results show that 40% of respondents (n=40) indicated the unit rate method as the most commonly applied approach, while 25% (n=25) used the resource-based method, 20% (n=20) preferred the historical cost method, and 15% (n=15) relied on expert judgment. This finding indicates that the majority depend on the unit rate method, which is based on standardized cost measures derived from the bill of quantities.

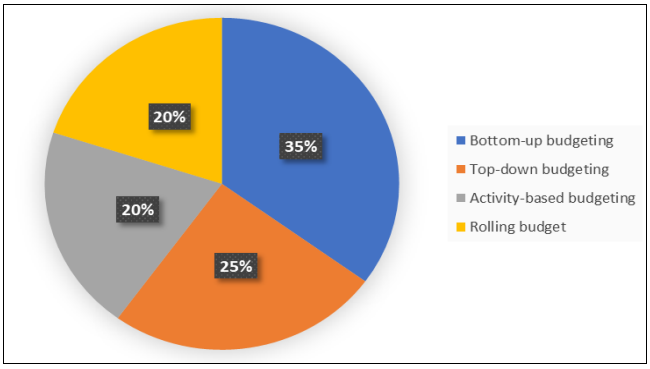

Fig 4.2.2: Budgeting approach

Findings reveal that bottom-up budgeting is most widely used, accounting for 35% (n=35) of responses. Top-down budgeting follows with 25% (n=25), while activity-based budgeting and rolling budgets are each used by 20% (n=20) of respondents. This result suggests that budgeting is largely developed from detailed activity inputs, emphasizing the participation of project-level staff in financial planning.

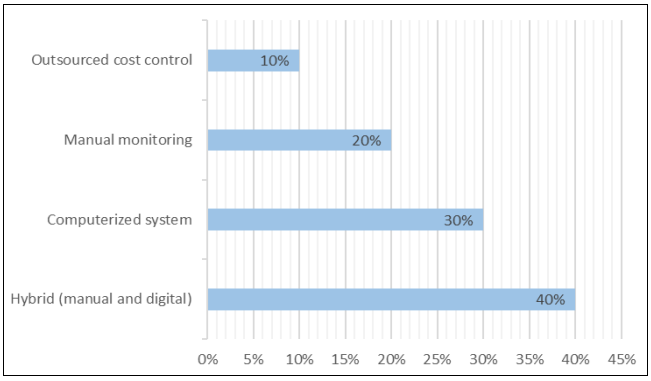

Fig 4.2.3: Cost control system

A hybrid system that combines manual and digital monitoring was used by 40% (n=40) of respondents, followed by computerized systems at 30% (n=30), manual monitoring at 20% (n=20), and outsourced cost control at 10% (n=10). The prevalence of hybrid systems indicates a transition toward digital cost management while maintaining manual processes for validation and reporting.

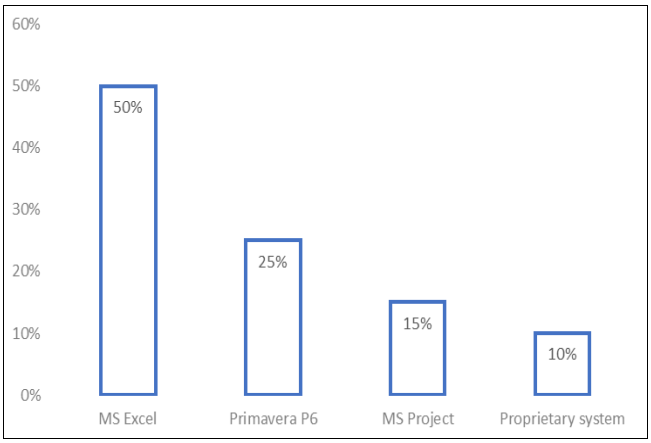

Fig 4.2.4: Cost tracking tool

The findings show that MS Excel is used by 50% (n=50) of respondents, Primavera P6 by 25% (n=25), MS Project by 15% (n=15), and proprietary systems by 10% (n=10). This demonstrates a strong preference for MS Excel due to its accessibility and flexibility in data handling. However, the limited use of specialized software such as Primavera P6 suggests underutilization of automated tools that offer real-time cost tracking and schedule integration.

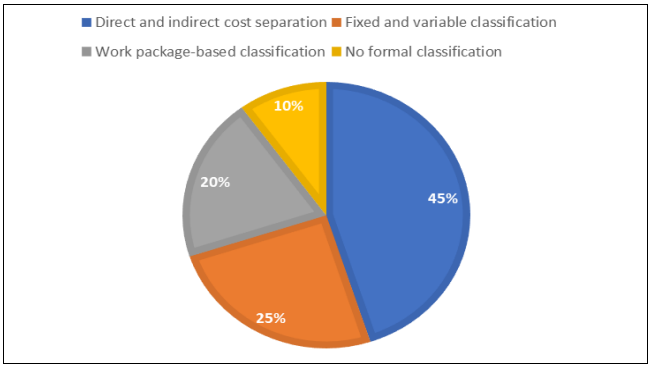

Fig 4.2.5: Cost classification method

About 45% (n=45) use direct and indirect cost classification, 25% (n=25) use fixed and variable classification, 20% (n=20) use work package-based classification, and 10% (n=10) have no formal classification. This finding shows that most projects apply conventional accounting methods to separate direct and indirect costs.

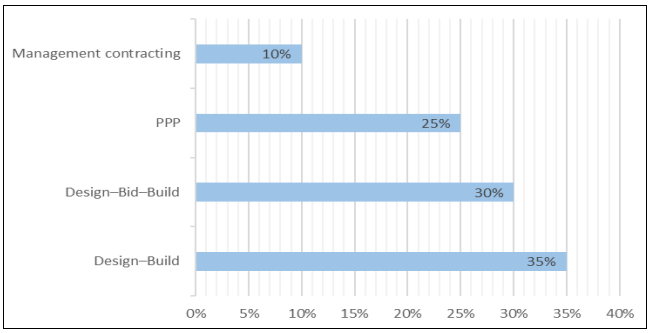

Fig 4.2.6: Procurement method influencing cost management

The Design–Build method is considered most influential by 35% (n=35) of respondents, followed by Design–Bid–Build at 30% (n=30), Public–Private Partnership (PPP) at 25% (n=25), and management contracting at 10% (n=10). The dominance of Design–Build indicates a preference for integrated delivery methods that improve coordination between design and construction.

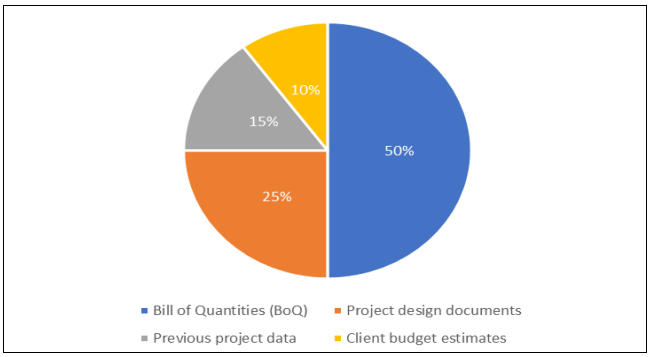

Fig 4.2.7: Basis for preparing the cost plan

Half of the respondents (50%, n=50) rely on the Bill of Quantities (BoQ) for preparing cost plans, 25% (n=25) depend on project design documents, 15% (n=15) on previous project data, and 10% (n=10) on client budget estimates. The widespread use of BoQs highlights its importance as a standardized cost planning tool in construction projects.

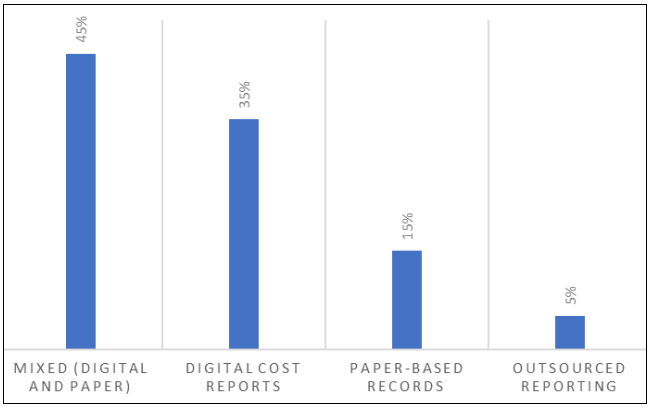

Fig 4.2.8: Cost documentation format

A mixed documentation format combining digital and paper records is maintained by 45% (n=45) of respondents. Digital-only reports account for 35% (n=35), paper-based records for 15% (n=15), and outsourced reporting for 5% (n=5). The use of mixed formats suggests an ongoing shift toward digitalization, constrained by regulatory requirements for physical documentation or limited ICT resources.

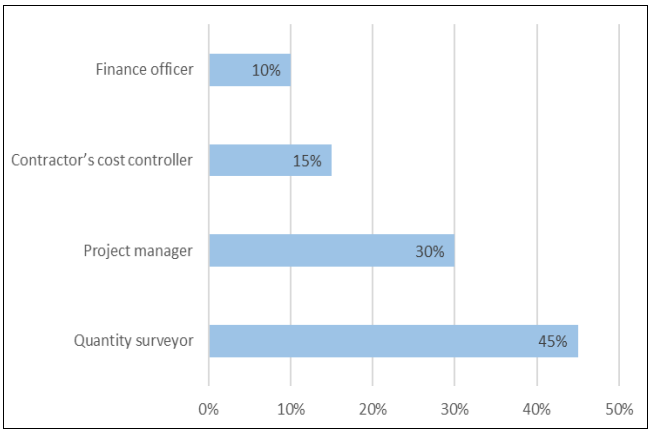

Fig 4.2.9: Responsibility for cost management

The majority (45%, n=45) identified quantity surveyors as primarily responsible for cost management. Project managers accounted for 30% (n=30), contractors' cost controllers for 15% (n=15), and finance officers for 10% (n=10). This distribution confirms that cost management functions remain mainly within the technical domain of quantity surveying, with limited integration across financial or administrative teams.

Table 4.2.1: Association Between Frequency of Budgeting Strategy Revisions and Alignment of Initial Budget with Actual Project Needs

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	96.667[a]	6	.000
Likelihood Ratio	112.288	6	.000
Linear-by-Linear Association	1.820	1	.132
N of Valid Cases	100		

The relationship between the frequency of budgeting strategy revisions and the alignment of the initial budget with actual project needs was examined using the Chi-Square test. The results indicated a statistically significant association (Pearson Chi-Square = 96.667, df = 6, p = 0.000), suggesting that projects with more frequent budget revisions tended to have better alignment between planned and actual costs.

4.3 Effectiveness of current cost management processes in the Lusaka-Ndola Dual Carriageway project

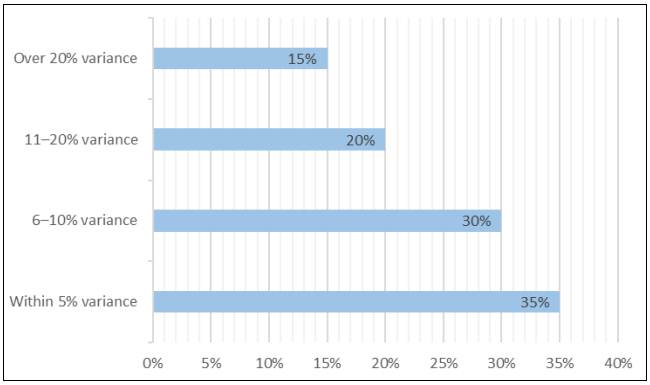

Fig 4.3.1: Accuracy of cost estimates

About 35% (n=35) of respondents reported that cost estimates were accurate within 5% variance, 30% (n=30) reported 6–10% variance, 20% (n=20) experienced 11–20% variance, and 15% (n=15) reported deviations above 20%. This indicates that most cost estimates closely align with actual project costs, suggesting robust estimation practices, though a portion still face significant deviations due to market and design changes.

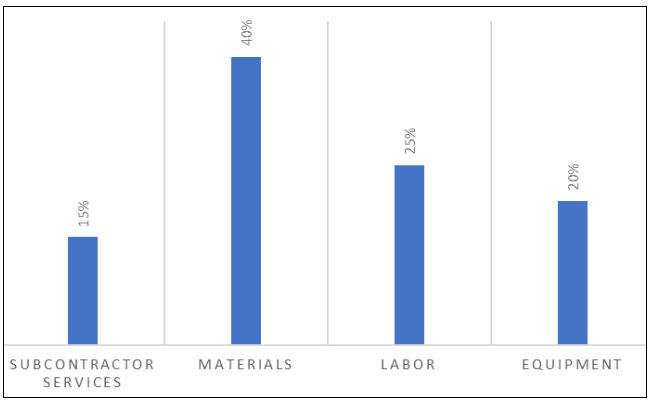

Fig 4.3.2: Areas of cost overruns

The findings show that materials experience the highest cost overruns at 40% (n=40), followed by labor at 25% (n=25), equipment at 20% (n=20), and subcontractor services at 15% (n=15). Material-related overruns highlight sensitivity to price fluctuations, especially in imported inputs such as steel and cement, which affect overall project costs.

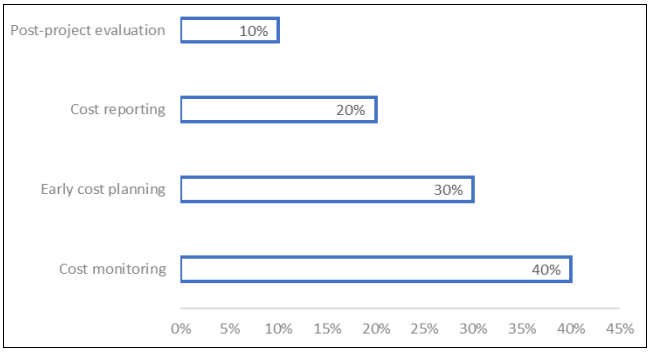

Fig 4.3.3: Process contributing most to efficiency

Cost monitoring was selected by 40% (n=40), early cost planning by 30% (n=30), cost reporting by 20% (n=20), and post-project evaluation by 10% (n=10). The emphasis on monitoring shows that continuous observation of cost performance is seen as central to maintaining control, though limited focus on post-project evaluation may reduce opportunities for learning.

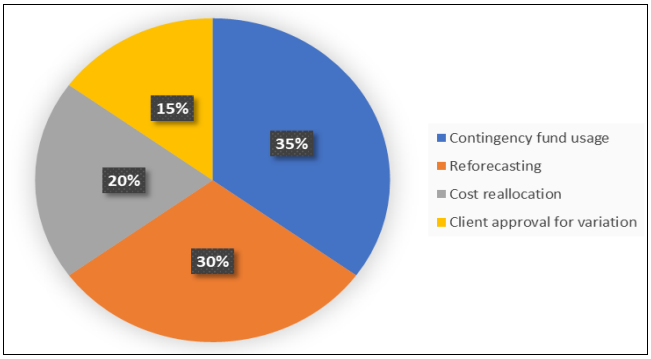

Fig 4.3.4: Handling deviations from budget

The most common strategy is contingency fund usage (35%, n=35), followed by reforecasting (30%, n=30), cost reallocation (20%, n=20), and client approval for variations (15%, n=15). This suggests that projects prioritize financial buffers to address unforeseen costs rather than revising forecasts regularly.

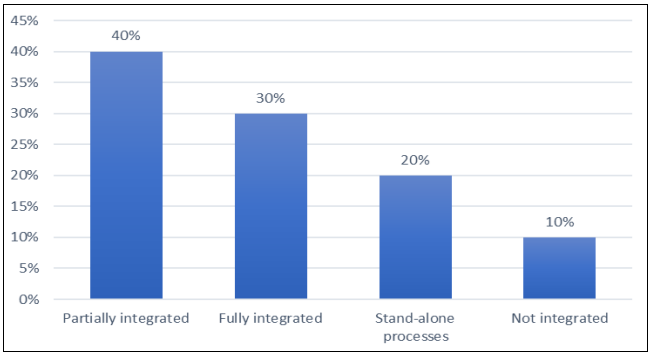

Fig 4.3.5: Integration of cost management and scheduling

Most respondents (40%, n=40) indicated partial integration, while 30% (n=30) reported full integration, 20% (n=20) said they operate as stand-alone processes, and 10% (n=10) stated they are not integrated. This partial linkage reflects the use of separate systems for cost and schedule management, limiting real-time synchronization.

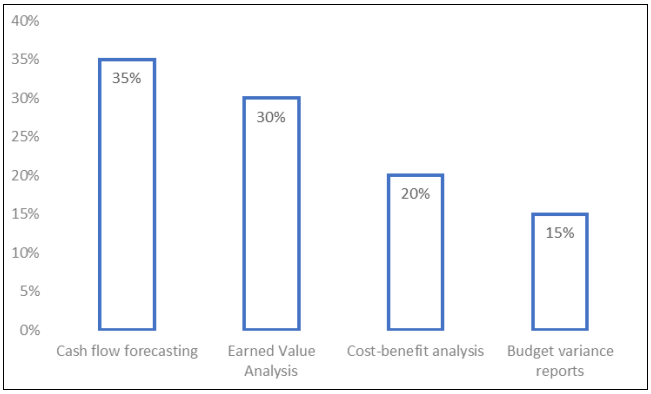

Fig 4.3.6: Financial control tools supporting decision-making

Cash flow forecasting was chosen by 35% (n=35) of respondents, followed by Earned Value Analysis (30%, n=30), cost-benefit analysis (20%, n=20), and budget variance reports (15%, n=15). This indicates a focus on liquidity and financial stability, with limited emphasis on performance-based evaluation tools.

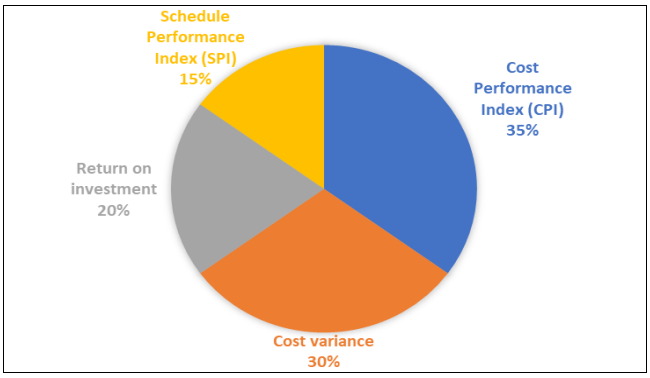

Fig 4.3.7: Indicator for cost efficiency

The Cost Performance Index (CPI) is the main indicator used by 35% (n=35), followed by cost variance at 30% (n=30), return on investment at 20% (n=20), and Schedule Performance Index (SPI) at 15% (n=15). These metrics highlight the importance of comparing actual and planned costs to gauge efficiency.

4.4 Limitations in cost management processes in construction projects in the Lusaka-Ndola Dual Carriageway project

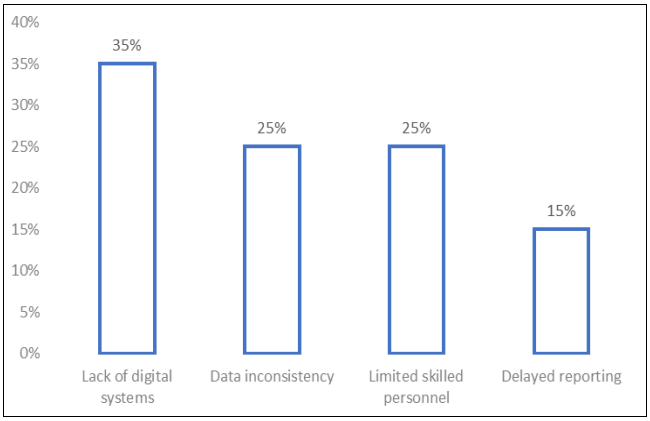

Fig 4.4.1: Challenge in maintaining accurate cost data

The main challenge identified was lack of digital systems (35%, n=35), followed by data inconsistency (25%, n=25), limited skilled personnel (25%, n=25), and delayed reporting (15%, n=15). This demonstrates that inadequate digital infrastructure and training are major barriers to maintaining accurate and timely cost data.

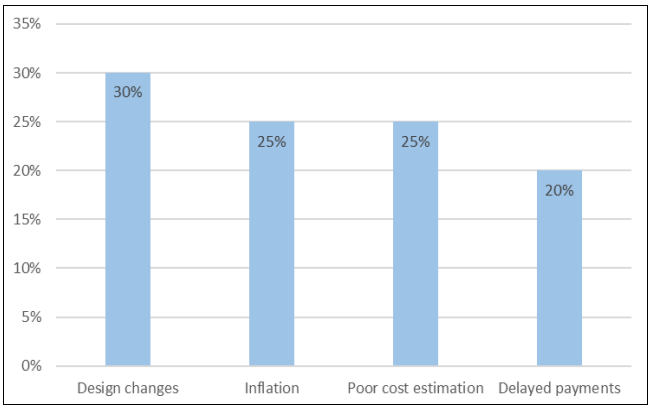

Fig 4.4.2: Factors contributing to cost overruns

Design changes (30%, n=30) were the leading cause of overruns, followed by inflation (25%, n=25), poor cost estimation (25%, n=25), and delayed payments (20%, n=20). These findings show that both internal (design changes) and external (inflation) factors significantly impact cost stability.

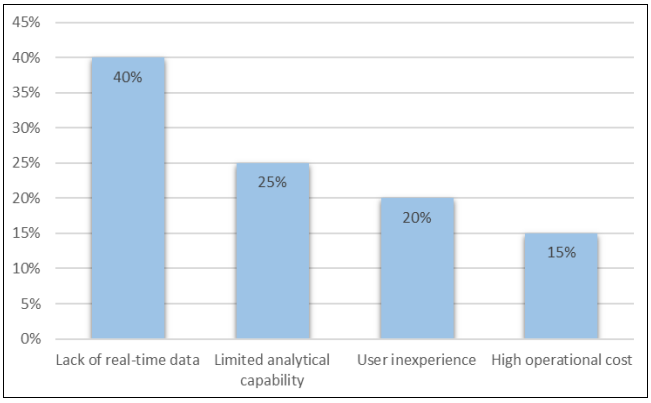

Fig 4.4.3: Limitations in cost control tools

The lack of real-time data was cited by 40% (n=40), limited analytical capability by 25% (n=25), user inexperience by 20% (n=20), and high operational cost by 15% (n=15). This implies that outdated or inefficient systems hinder timely cost decision-making.

Table Relationship Between Accuracy of Cost Data and Limitations in Cost Control Tools

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	96.667[a]	6	.001
Likelihood Ratio	112.288	6	.001
Linear-by-Linear Association	1.820	1	.002
N of Valid Cases	100		

The Chi-square test examined the relationship between the primary challenge in maintaining accurate cost data and the biggest limitation in cost control tools. The results show a significant association between the two variables (χ^2 = 96.667, df = 6, p = 0.001). This indicates that the accuracy of cost data is strongly influenced by the functionality and efficiency of cost control tools. Firms that reported lack of digital systems as a major challenge in maintaining cost data were also more likely to identify lack of real-time data and limited analytical capability as key limitations in their cost control tools. Similarly, firms citing delayed reporting often experienced user inexperience and poor data integration issues.

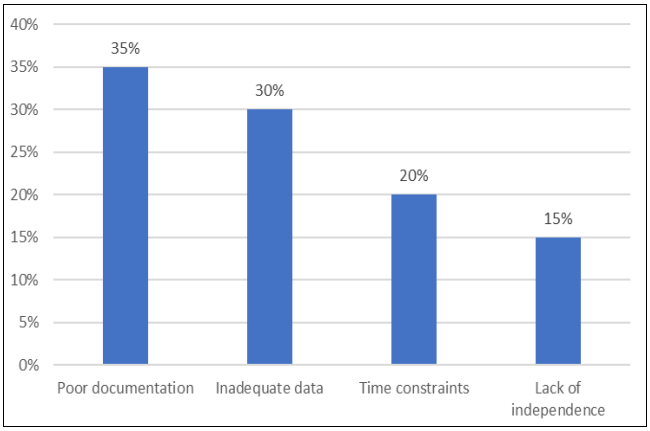

Fig 4.4.4: Limitations of cost audits

Poor documentation (35%, n=35) was the main constraint, followed by inadequate data (30%, n=30), time constraints (20%, n=20), and lack of independence (15%, n=15). This suggests that weak record management and time pressures compromise audit reliability.

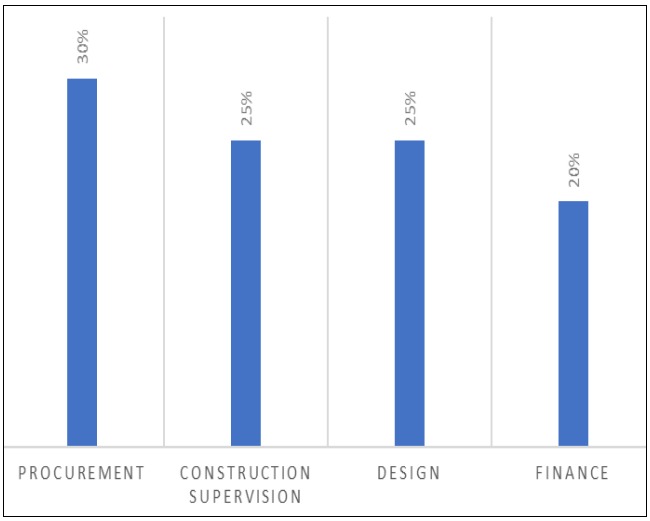

Fig 4.4.5: Areas lacking coordination

Procurement (30%, n=30) was found to have the most coordination gaps, followed by construction supervision (25%, n=25), design (25%, n=25), and finance (20%, n=20). Weak coordination in procurement points to fragmented cost control during material acquisition.

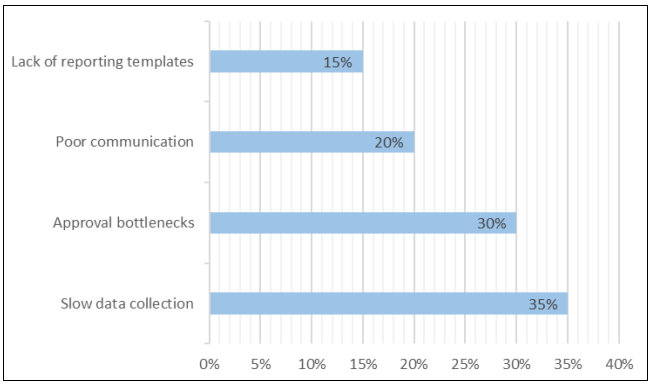

Fig 4.4.6: Causes of cost reporting delays

The most cited cause is slow data collection (35%, n=35), followed by approval bottlenecks (30%, n=30), poor communication (20%, n=20), and lack of reporting templates (15%, n=15). This highlights process inefficiencies and weak communication flows between project teams.

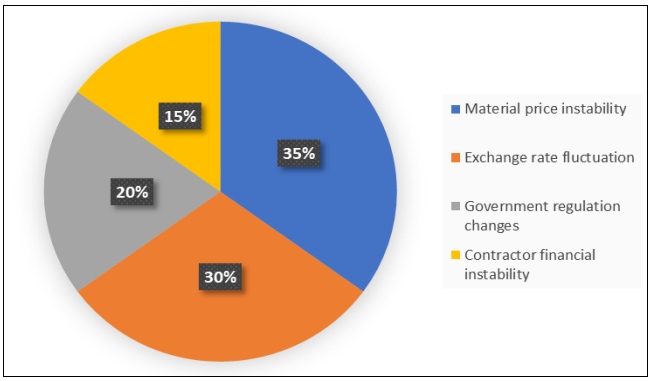

Fig 4.4.7: External factors affecting cost management

Material price instability was identified by 35% (n=35), exchange rate fluctuation by 30% (n=30), government regulation changes by 20% (n=20), and contractor financial instability by 15% (n=15). The findings show that macroeconomic instability has a strong influence on project cost management outcomes.

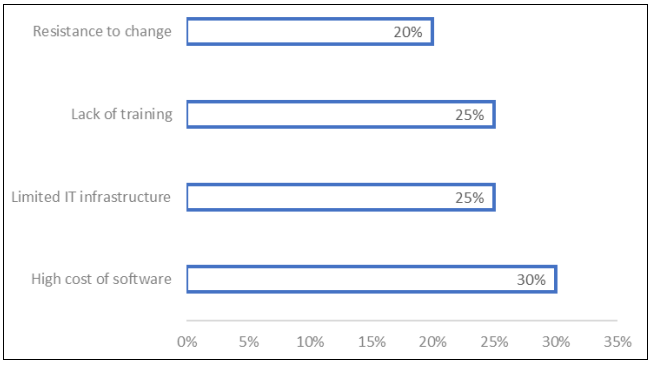

Fig 4.4.8: Limitations to digital system adoption

The high cost of software (30%, n=30) was the main limitation, followed by limited IT infrastructure (25%, n=25), lack of training (25%, n=25), and resistance to

change (20%, n=20). This suggests financial and technical barriers to implementing digital cost systems.

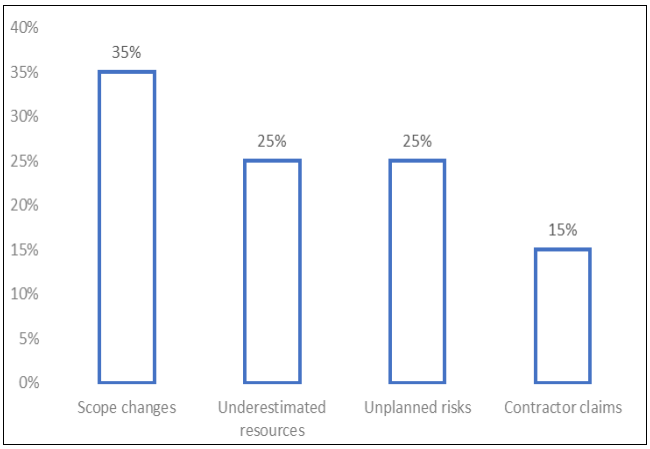

Fig 4.4.9: Source of budget variance

Scope changes (35%, n=35) were the leading source, followed by underestimated resources (25%, n=25), unplanned risks (25%, n=25), and contractor claims (15%, n=15). This highlights that budget deviations mainly result from project scope modifications.

4.5 Discussions

Objective I: Types of cost management practices used in the Lusaka-Ndola Dual carriageway project

The study revealed that 40% of respondents used the unit rate estimation method, 25% used resource-based methods, 20% relied on historical cost methods, and 15% applied expert judgment. The dominance of the unit rate approach demonstrates the reliance on standardized cost data derived from Bills of Quantities (BoQs), which remains the benchmark for pricing construction work in Zambia. This finding is consistent with Mutale (2021), who emphasized that the Road Development Agency (RDA) and other public institutions depend on unit rate pricing to ensure cost transparency and competitive bidding.

The study revealed that 35% of respondents identified the Design–Build approach as most influential, followed by Design–Bid–Build (30%), Public–Private Partnership (PPP) (25%), and management contracting (10%). The dominance of Design–Build reflects a shift toward integrated procurement models that merge design and construction responsibilities under one contractor. The limited use of management contracting (10%) suggests that flexible contracting is less common in Zambia's public works, likely due to administrative constraints and limited technical capacity for managing multiple subcontracts. Half of respondents (50%) indicated reliance on the Bill of Quantities (BoQ), 25% on project design documents, 15% on previous project data, and 10% on client budget estimates. The dominance of BoQs confirms their continued role as the foundation of cost planning in Zambian construction. This aligns with Elmousalami (2020) [23], who noted that BoQs standardize cost estimation, enable competitive bidding, and facilitate transparent payment certification.

The Chi-Square analysis ($\chi^2 = 96.667$, df = 6, p = 0.000) revealed a significant association between frequent budget revisions and better alignment between planned and actual project needs. This indicates that adaptive budgeting—where project budgets are periodically reviewed—improves cost accuracy. This aligns with Amin (2021) and Wang (2024), who found that continuous reforecasting and rolling budgets enhance responsiveness to market and operational changes. The result also supports Changala (2024) [16], who argued that inflexible planning contributes to project cost overruns in Zambia's road sector. Regular revisions allow project managers to incorporate updated material prices, weather delays, and design modifications, thus minimizing deviations.

Objective II: The effectiveness of current cost management processes in the Lusaka-Ndola Dual carriageway project

The study found that 35% of respondents reported that cost estimates were accurate within a 5% variance, 30% experienced variances between 6–10%, 20% experienced 11–20%, and 15% reported deviations above 20%. These results suggest that while a majority of estimates were within acceptable limits, a notable portion still experienced significant deviations due to market changes and scope modifications. This pattern aligns with Mushori (2020), who emphasized that in large infrastructure projects, cost estimation accuracy depends on the availability of reliable data, detailed designs, and stable market conditions.

The chi-square analysis between the accuracy of cost data and limitations in cost control tools produced a statistically significant relationship ($\chi^2 = 96.667$, df = 6, p = 0.001), confirming that weaknesses in data accuracy are closely related to tool limitations such as lack of real-time data and limited analytical capability. Firms without digital systems tend to experience delays in cost updates and limited integration between field data and management reports. For instance, projects using spreadsheet-based tracking struggle to consolidate cost information from multiple sources, which undermines transparency and timely decision-making.

Poor cost estimation practices were also a recurring theme. As observed by Choi (2023) and Awuku (2024), inadequate baseline estimates result from limited feasibility analysis and reliance on incomplete project data. When cost forecasts fail to reflect true market conditions, even minor design or schedule changes can produce significant financial variances. Delayed payments further compounded this problem by creating cash flow challenges for contractors and suppliers, slowing down progress and increasing costs through interest charges and penalties. The relationship between cost overruns and budget variance sources was statistically significant ($\chi^2 = 96.667$, df = 6, p = 0.001), confirming that the same factors causing cost overruns also drive budget variances. For instance, firms identifying design changes and poor estimation as key causes of overruns also reported scope changes and underestimated resources as main sources of variance. The biggest limitations reported in cost control tools were lack of real-time data (40%), limited analytical capability (25%), high operational cost (20%), and user inexperience (15%). These findings indicate that the effectiveness of cost control depends not only on the availability of tools but also on their functionality and user competence. Similar to findings by Rao (2022), many organizations adopt digital cost control systems but fail to integrate them with scheduling, procurement, and reporting systems. This results in fragmented data and inconsistent cost updates. The chi-square results ($\chi^2 = 96.667$, df = 6, p = 0.001) confirm that firms lacking real-time data often struggle with cost

accuracy and reporting delays. Without live cost feeds from on-site activities, project managers cannot identify financial deviations early enough to implement corrective measures. Limited analytical capability also restricts the ability to perform cost forecasting and scenario analysis, which are critical for large infrastructure projects.

5. Conclusions and Recommendations

5.1 Conclusions

The study concludes that cost management in the Lusaka–Ndola Dual Carriageway Project demonstrates a structured yet partially modernized approach, combining traditional techniques with emerging digital tools. The predominance of the unit rate method and bottom-up budgeting indicates reliance on established, task-specific financial planning practices, while hybrid monitoring systems and MS Excel usage reflect gradual adoption of digital processes. Cost estimates generally aligned with actual expenditures, particularly for materials, labor, and equipment, although material price fluctuations and design changes contributed significantly to overruns. Integration between cost management and scheduling was only partial, limiting real-time decision-making, and contingency funds were the primary strategy for handling deviations. Key limitations included inadequate digital infrastructure, inconsistent data, limited skilled personnel, and institutional inefficiencies such as weak policies and bureaucratic delays, which collectively impacted cost control and reporting. Statistical analysis confirmed significant relationships between the frequency of budget revisions and alignment with actual costs, as well as between sources of budget variance and cost overruns, indicating that proactive monitoring and accurate forecasting are critical for maintaining financial control.

5.2 Recommendations

Enhance Digital Cost Management Systems: Invest in advanced project management and cost tracking software, such as Primavera P6 or integrated ERP systems, to enable real-time monitoring of project expenditures, schedule integration, and automated variance analysis. This will reduce reliance on manual and hybrid systems, improve accuracy, and facilitate timely decision-making.

Strengthen Staff Capacity and Training: Provide targeted training for quantity surveyors, project managers, and finance officers on modern cost management practices, digital tools, and financial analysis techniques. Improving staff competency will enhance data accuracy, interpretation, and effective use of cost control tools.

Improve Data Accuracy and Integration: Develop standardized procedures for collecting, validating, and integrating cost data across project teams. Ensuring consistency between design, procurement, and construction data will reduce reporting delays, minimize errors, and improve coordination.

Increase Use of Activity-Based and Performance-Based Budgeting: Encourage broader adoption of activity-based budgeting and performance-linked financial planning to allow detailed allocation of resources, better cost control, and evaluation of efficiency at the task level. Linking budgets to measurable outcomes can also support accountability and continuous improvement.

Enhance Contingency Planning and Forecasting: Expand the use of contingency allowances and dynamic reforecasting mechanisms to better handle unforeseen events such as material price fluctuations, design changes, and adverse weather. Regular budget revisions, supported by data-driven forecasts, can improve alignment with actual costs.

Strengthen Integration of Cost and Schedule Management: Promote full integration of cost control and project scheduling systems to allow real-time updates on both expenditure and project progress. This will enhance responsiveness to delays and cost deviations.

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