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

[1] Mabvuto Chambule, [2] Kelvin Chibomba

[1, 2] School of Humanities and Social Sciences, Information and Communication University, Lusaka, Zambia

Corresponding Author: **Mabvuto Chambule**

Abstract

Cost management is a critical component of project management, as it directly influences the ability of an organization to deliver projects within budget, on time, and to the required standards. Effective cost management techniques provide project managers with tools to estimate, allocate, control, and monitor financial resources throughout the project lifecycle. These techniques not only help prevent cost overruns but also support informed decision-making, resource optimization, and alignment of project objectives with organizational goals. In today's competitive environment, where projects face increasing complexity and financial constraints, adopting structured cost management practices such as budgeting, forecasting, earned value management, and cost-benefit analysis is essential. This study focused on examining the effectiveness of cost management techniques in project management within road construction projects in Lusaka. Specifically, it sought to assess the cost management techniques currently in use, determine their effectiveness, analyze the relationship between these techniques and project performance, and identify the limitations that affect their application in practice. The study adopted a case study design and utilized a mixed-methods approach to collect primary data. Data entry and analysis were carried out using STATA, with descriptive statistics such as frequencies, percentages, and means applied to summarize the findings. Associations between variables were examined using the Chi-square test, while qualitative data was analyzed through thematic analysis. The study revealed that budget forecasting (78%), cost-benefit analysis (70%), and earned value management (62%) were the most commonly applied techniques, while value engineering (45%) and lifecycle costing (38%) were less frequent. Cost-benefit analysis was rated "Important" or "Very important" by 80% of respondents, and documentation practices were considered "Good" (35%) or "Excellent" (25%). Cost management techniques reduced overruns "to a large extent" for 42% of participants, with 80% reporting effectiveness in staying within budget and 65% rating forecasting ability as "Good" or "Excellent." Digital tools were viewed as effective by 65%, and 68% confirmed responsiveness to unexpected changes. Cost management's impact on project success was rated "High" (42%) or "Very high" (28%), with accurate budgeting influencing quality (70%) and stakeholder satisfaction (75%). Key challenges included bureaucratic delays (75%), limited real-time financial data (75%), inflation and fuel volatility (70%), resistance to new technologies (70%), and inaccurate initial estimates (70%). Based on the findings, the study recommends that road construction projects in Lusaka strengthen the use of structured cost management techniques such as budget forecasting, cost-benefit analysis, and earned value management, while also increasing the adoption of less-utilized methods like value engineering and lifecycle costing to enhance long-term financial efficiency. Project managers should integrate digital tools and real-time financial monitoring systems to improve responsiveness to unexpected changes and reduce the impact of inflation and market volatility. Training and capacity building should be prioritized to address resistance to new technologies and improve forecasting accuracy, while streamlining bureaucratic processes will minimize delays in financial approvals.

Keywords: Cost Management, Cost Management Techniques, Project Performance

1. Introduction

1.1 Background

Cost management is a critical aspect of project management that involves planning, estimating, budgeting, financing, funding, managing, and controlling costs to complete a project within the approved budget (Hanioglu, 2022). Effective cost management techniques are essential in ensuring that projects achieve their objectives without financial overruns, which can negatively impact project timelines, quality, and stakeholder satisfaction (Chipandwe, 2025). The discipline of cost management is particularly important in construction projects, where complexity, resource intensity, and external variables often lead to cost overruns and delays (Kabwe, 2025).

At a global level, road construction projects represent a significant portion of infrastructure investment aimed at improving connectivity, economic development, and social welfare (Yang, 2020). Countries worldwide have adopted various cost management frameworks and tools such as Earned Value Management (EVM), Cost-Benefit Analysis (CBA), and Value Engineering (VE) to control expenditures and optimize resource utilization (Sobh, 2024).

Regionally, in Sub-Saharan Africa, infrastructure development, particularly road construction, is a strategic priority due to its direct link to economic growth and regional integration (Mutiiria, 2020). However, many countries in the region continue to experience challenges such as inadequate project planning, limited technical capacity, and weak cost control systems (Appiah, 2022). These issues often lead to cost overruns, delayed project completion, and underperformance of road infrastructure, undermining economic benefits. Recent efforts in the region emphasize adopting best practices in cost management to enhance project delivery efficiency and financial accountability (Okolie, 2023).

Locally, in Lusaka, Zambia, road construction projects play a vital role in supporting urban development, improving transportation networks, and facilitating trade (Mutungwa, 2024). The city has seen increased investment in road infrastructure to address traffic congestion, improve safety, and support economic activities. However, many projects have experienced cost overruns, delays, and quality issues, raising concerns about the effectiveness of cost management practices employed (Bobo, 2021) [5]. The Zambian government has introduced policies and standards aimed at improving project management practices, including the Public Procurement Act and the National Construction Council guidelines (Mambwe, 2020). Despite these frameworks, practical challenges persist due to limited expertise, inadequate monitoring mechanisms, and variations in contractor performance. Examining the effectiveness of cost management techniques in the Lusaka-Ndola dual carriageway road construction project will provide valuable insights into how cost control can be improved to enhance project outcomes and resource utilization. This study will analyze the effectiveness of cost management techniques in the Lusaka-Ndola dual carriageway their application, and effectiveness in Lusaka's road construction project to identify gaps and recommend improvements. Understanding these dynamics will assist policymakers, contractors, and project managers in optimizing cost management practices, contributing to more successful project delivery and infrastructure development.

1.2 Statement of Problem

Road construction projects in Lusaka continue to face significant challenges related to cost overruns and budget mismanagement (Sichone, 2020). Despite the adoption of various cost management techniques, many projects exceed their initial budgets by substantial margins, resulting in delays, compromised quality, and inefficient use of public resources (Ajayi, 2024). Rivera (2020) found that delays in road construction projects are common. On average, the actual time taken to complete new road projects is about 160% of the planned schedule. These delays negatively impact all parties involved, leading to strained relationships, mistrust, legal disputes, financial difficulties, and heightened stress. This challenge is not unique to developed nations; it also affects developing countries (Rivera, 2022). Herrera (2020) conducted a frequency and importance analysis revealing that 55% of 2,668 road projects in the United States experienced cost overruns. In Australia, an analysis of 231 road projects showed an average cost overrun of 16.3%, while a separate review of 49 Australian road projects reported a mean overrun of 13.5%. Additionally, among 37 road projects examined in the Netherlands, 62.2% had cost overruns, with an average deviation of 18.6%. Rwakarehe and Mfinanga also studied seven road projects in Tanzania and found an average cost overrun of 44% (Herrera, 2020). This persistent problem points to a gap in understanding how well cost management techniques are applied in the context of the Lusaka-Ndola dual carriageway road construction projects and whether these techniques adequately address the unique challenges faced locally, such as fluctuating material costs, contractor capacity, and project scope changes (Mutungwa, 2024). This situation calls for focused research to evaluate current cost control methods, identify gaps, and recommend improvements tailored to Lusaka's construction environment. Therefore, this study is necessary to provide evidence-based insights into the effectiveness of cost management techniques in road construction projects.

1.3 General Objectives

To examine the effectiveness of cost management techniques in the Lusaka-Ndola dual carriageway road construction project.

1.3.1 Specific Objectives

1. To establish cost management techniques used in the Lusaka-Ndola dual carriageway road construction project.
2. To determine the effectiveness of cost management techniques used in the Lusaka-Ndola dual carriageway road construction project.
3. To analyze the relationships between cost management techniques and project performance in the Lusaka-Ndola dual carriageway road construction project.
4. To identify the limitations of cost management techniques used in the Lusaka-Ndola dual carriageway road construction project.

1.4 Research Questions

1. What cost management techniques were used in the Lusaka-Ndola dual carriageway road construction project?
2. How effective were cost management techniques used in the Lusaka-Ndola dual carriageway road construction projects?
3. What is the relationship between cost management techniques and project performance in the Lusaka-Ndola Dual carriageway road construction project?
4. What were the limitations of cost management techniques used in the Lusaka-Ndola dual carriageway road construction project?

2. Literature Review

2.1 Cost Management Techniques Used in Road Construction Projects

Cost management in road construction projects involves a set of techniques and practices that help project teams plan, monitor, and control costs throughout the project life cycle. Given the scale and complexity of road construction,

effective cost management is essential to avoid overruns, delays, and resource wastage. The following are commonly used cost management techniques in road construction projects:

Cost estimation is a fundamental cost management technique used in road construction projects, involving the process of forecasting the total expenses required to complete a project before actual work begins (Ahmed, 2020). This technique plays a critical role in project planning and budgeting by providing a financial blueprint that guides decision-making throughout the project lifecycle. Cost estimation requires a detailed analysis of all components that contribute to the overall cost, including materials, labor, equipment, overheads, and contingency allowances (Del Pico, 2023).

Budgeting is a critical cost management technique that involves the systematic allocation of financial resources to different activities and phases within a road construction project, based on the initial cost estimates (Hanioglu, 2022). It serves as a financial roadmap, guiding how funds are distributed throughout the project lifecycle to ensure that each component receives adequate funding for successful completion. Budgeting transforms cost estimates into a structured financial plan that details how much money will be spent, when it will be spent, and on what specific activities, thereby enabling effective financial control and oversight (Jayamaha, 2024). In public sector road projects, this is particularly important to ensure responsible use of public funds and maintain trust (Vigneault, 2020).

Cost control is a vital cost management technique that focuses on monitoring and regulating actual project expenditures to ensure they align with the approved budget. In road construction projects, where budgets are often large and complex, effective cost control helps prevent overspending and ensures that financial resources are used efficiently throughout the project lifecycle (Markiz, 2022). The goal of cost control is to detect any deviations from the budget early enough so that corrective actions can be taken to keep the project financially on track (Ahmed, 2020).

Earned Value Management (EVM) is an integrated project control technique that combines scope, cost, and schedule data to assess and manage project performance effectively (Muharremi, 2025).

In road construction projects, EVM can be particularly beneficial due to the phased nature of activities such as site preparation, earthworks, paving, and finishing. Project managers can track each phase's progress against the original plan, identifying areas where work is ahead of or behind schedule or where costs are exceeding expectations (Muharremi, 2022).

Value engineering is also a cost control technique used in road construction project. An important aspect of value engineering is that it involves a collaborative process. Project stakeholders including engineers, contractors, designers, and sometimes clients engage in workshops or reviews to discuss possible alternatives and assess their implications (Chipandwe, 2025). Each proposal is evaluated not only on cost but also on performance, durability, safety, and environmental impact. This ensures that decisions are not made purely on financial grounds but take into account the long-term effectiveness of the road infrastructure (Bobo, 2021) [5].

2.2 The effectiveness of cost management techniques in road construction projects

The effectiveness of cost management techniques in road construction projects is critical for ensuring that projects are completed within budget, on time, and with the intended quality. Road construction projects are often complex and resource-intensive, involving a range of activities such as planning, procurement, site preparation, and execution (Holm, 2021). Effective cost management techniques help project managers plan, monitor, and control financial resources to avoid overspending and ensure value for money. One of the most effective techniques is Earned Value Management (EVM), which combines scope, schedule, and cost data to assess project performance (Kabwe, 2025).

EVM allows managers to track actual progress against planned progress and calculate variances. In road construction, where delays and budget overruns are common, EVM provides early warnings of problems and helps decision-makers take corrective action before costs escalate. It enhances financial visibility and strengthens accountability (Khas, 2023).

Earned Value Management (EVM) was among the most effective techniques, integrating scope, schedule, and cost data to assess project performance (Kabwe, 2025). EVM enabled managers to compare actual progress with planned progress and calculate cost and schedule variances. In the context of road construction, where delays and budget overruns were common, EVM provided early warnings of potential problems and allowed decision-makers to implement corrective measures before costs escalated (Khas, 2023). Research further demonstrated that projects employing EVM showed higher adherence to budgets and schedules compared to those relying solely on traditional cost monitoring methods (Priyo, 2021).

Value engineering (VE) was another effective cost management technique. VE involved analyzing construction methods, materials, and design alternatives to identify cost-effective solutions without compromising quality (Razi, 2021). For instance, substituting imported materials with locally available equivalents, optimizing pavement designs, or selecting alternative construction methods yielded substantial cost savings (Shamim, 2025). VE encouraged innovation, enhanced efficiency, and reduced resource wastage, ultimately improving the overall cost-effectiveness of road projects. Studies highlighted that incorporating VE during the design phase allowed project managers to address potential inefficiencies before construction commenced, which minimized mid-project budget adjustments and prevented scope creep (Priyo, 2021).

2.3 Relationships between cost management techniques and project performance in road construction projects

The relationship between cost management techniques and project performance in road construction projects was closely interconnected. Cost management techniques were recognized as essential tools that influenced multiple aspects of project performance, including time, quality, scope, and resource utilization (Ahmed, 2020). Their effective application led to more efficient project delivery, reduced financial waste, and enhanced stakeholder satisfaction.

Firstly, Earned Value Management (EVM) directly linked financial control with time and scope performance (Priyo, 2021). By integrating cost, schedule, and scope data, EVM enabled project managers to objectively measure performance. These insights allowed timely corrective actions, reducing the likelihood of significant delays or budget overruns (Edet, 2024). For instance, EVM provided performance indices such as the Cost Performance Index (CPI) and Schedule Performance Index (SPI), which allowed managers to identify areas where actual performance deviated from planned objectives. Previous studies indicated that projects implementing EVM consistently demonstrated better adherence to budget and schedule compared to those using traditional cost tracking methods (Priyo, 2021).

Value engineering (VE) is another technique that positively influenced project performance. VE sought cost-effective alternatives in materials, design, and construction methods without compromising quality (Oyegoke, 2022). For example, substituting traditional materials with more affordable yet durable alternatives reduced costs while improving road longevity. VE promoted efficient resource utilization and enhanced both economic and functional performance of road projects (Priyo, 2021). By integrating VE into project planning, contractors were able to reduce unnecessary expenditures, shorten construction timelines, and deliver higher-quality outcomes.

2.4 Limitations of cost management techniques in road construction projects

Cost management techniques in road construction projects are essential for controlling expenses, ensuring timely completion, and maintaining quality standards (Akpe, 2024). However, these techniques also face several limitations that reduce their effectiveness in real-world applications. In the context of road construction projects, one of the major limitations associated with cost management techniques is the inaccuracy of initial cost estimations (Del, 2023). These estimates often form the foundation upon which project budgets, resource allocations, and timelines are planned. However, they are frequently prone to errors that compromise the overall effectiveness of cost control. In many cases, cost projections are based on outdated data, assumptions from previous projects, or general industry benchmarks that do not reflect the unique conditions of the current project. This reliance on incomplete or obsolete information can lead to serious discrepancies between projected and actual costs (Kassa, 2020).

Poor forecasting also contributes significantly to the problem. Estimators may not have access to the latest market prices for construction materials, fuel, labor, or equipment, resulting in underestimations or overestimations (Obi, 2021). Additionally, the forecasting process may not adequately account for inflation, transportation costs, or fluctuations in foreign exchange rates, especially when importing equipment or materials. As a result, budgets that were considered feasible at the planning stage may quickly become unrealistic once the project is underway (Pavate, 2024).

Currency fluctuations also pose a major limitation. Road construction projects often rely on imported materials, machinery, or specialized equipment. When the project's local currency weakens against foreign currencies, the cost of imported inputs rises significantly (Elmousalami, 2020) [10].

3. Methodology

3.1 Research Design

In this study, an exploratory case study design was adopted (Olawale, 2023).

3.2 Target Population

The target population for this study consisted of project managers and engineers working for Macro Ocean Investment Consortium (MOIC-LN), the company constructing the Lusaka-Ndola dual carriageway project.

3.3 Sample Size

A sample is a subset of a population that is used to represent the entire group (Lohr, 2021). The study consisted of 50 project managers and Engineers of the MOIC-LN construction company.

3.4 Sampling

The study made use of a convenience sampling method. This choice was based on its practicality and feasibility in accessing study participants. Data was collected from individuals who were readily available and accessible.

3.5 Data Collection Methods

The main data collection method for this study was a structured questionnaire containing closed-ended questions. Information was gathered through structured surveys and interviews, using standardized questionnaires. Interviews were primarily conducted face-to-face.

3.6 Data Analysis

Data entry and statistical analysis were done using STATA. Presentation of descriptive statistics was done using Microsoft Excel 365. For inferential analysis, the Chi-square test was applied to assess relationships between categorical variables. Qualitative data were examined using thematic analysis, a systematic approach to identifying, organizing, and interpreting recurring patterns or "themes" within the responses. This method is particularly beneficial in mixed-methods research, as it offers rich insights and perspectives that deepen and complement the quantitative findings (Lugo-Armenta, 2024).

3.7 Ethical Consideration

The study upheld ethical aspects, including obtaining informed consent, safeguarding participant confidentiality and privacy, and utilizing acquired information solely for academic purposes. Stringent confidentiality measures were maintained, with data securely stored in a database accessible only to the researcher through a password.

4. Presentation of Findings

4.1 Background characteristics of the respondents

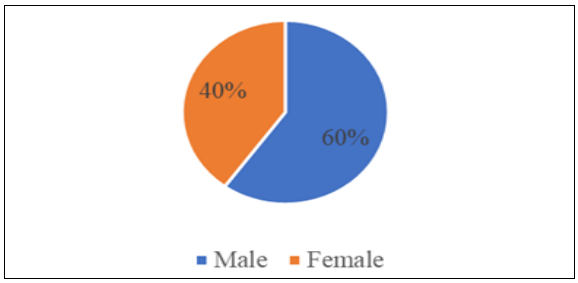

Fig 4.1.1: Gender of Respondent

The figure above shows that out of the 50 respondents, the majority 60% were males, while 40% were females, indicating a moderately male-dominated workforce in road construction projects surveyed.

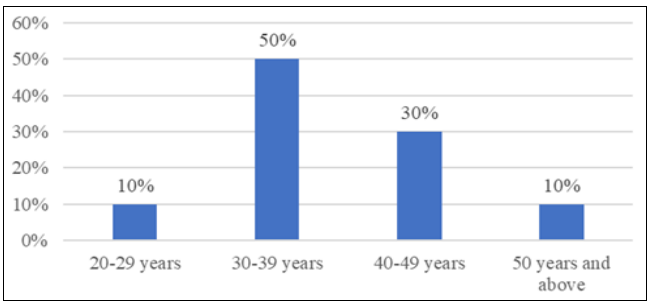

Fig 4.1.2: Age of Respondents

The age distribution indicates that most respondents were between 30–39 years (50%), followed by those aged 40–49 years (30%), 20–29 years and 50 years and above, each accounted for 10% respectively.

4.2 Cost Management Techniques used in the Lusaka-Ndola dual carriageway road construction project

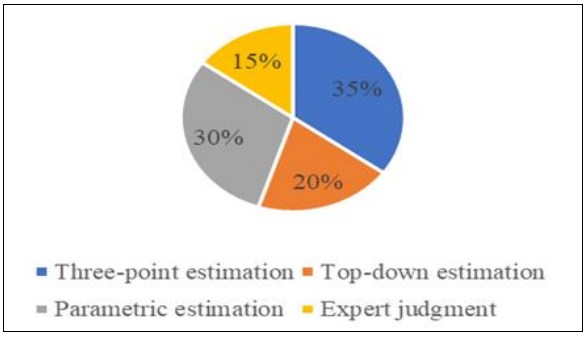

Fig 4.2.1: Cost estimation technique used

The study requested respondents to indicate the cost estimation technique used in road construction. 35% of the majority of respondents indicated three-point estimation, 30% of the respondents indicated parametric estimation, 20% of the respondents indicated top-down estimation, and 15% of the respondents indicated expert judgement.

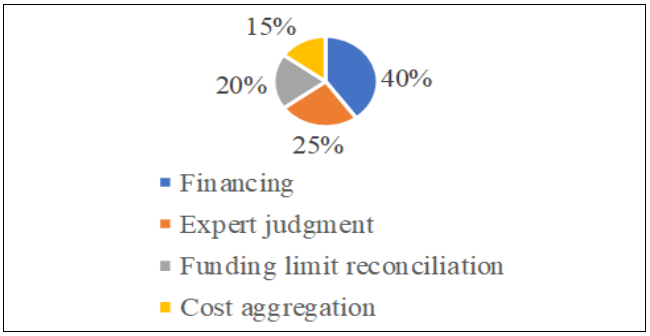

Fig 4.2.2: Determine Budget techniques

The study requested respondents to indicate the Determining Budget techniques. 40% of the majority of respondents indicated Financing, 25% of the respondents indicated expert judgment, 20% of the respondents indicated funding limit reconciliation, and 15% of the respondents indicated Cost aggregation.

Table 4.2.3: Cost control techniques regularly applied (Multiple Response)

	Responses		Percent of Cases
	N	Percent	
Budget forecasting	39	78%	39.0%
Earned Value Management (EVM)	31	70%	31.0%
Cost-benefit analysis	35	62%	35.0%
Value engineering	23	45%	23.0%
Lifecycle costing	19	38%	19.0%
Total	147	293.0%	147.0%
a. Dichotomy group tabulated at value 1.			

The majority of respondents (78%) used Budget forecasting as a cost management technique in road construction projects in Lusaka, 70% used cost-benefit analysis, 62% used Earned Value Management (EVM), 45% used value engineering, and the least proportion of respondents (38%) used lifecycle costing.

4.3 Effectiveness of Cost Management Techniques in the Lusaka-Ndola dual carriageway road construction project

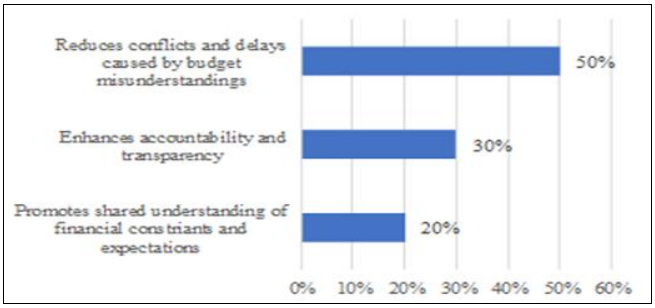

Fig 4.3.1: Effectiveness of meetings as a plan cost management technique in the Lusaka-Ndola dual carriageway

The figure above shows that the majority of respondents (50%) indicated that meetings as a plan cost management technique reduces conflicts and delays caused by budget

misunderstandings, 30% indicated that meetings enhance accountability and transparency, and 20% indicated that meetings promote shared understanding of financial constraints and expectations.

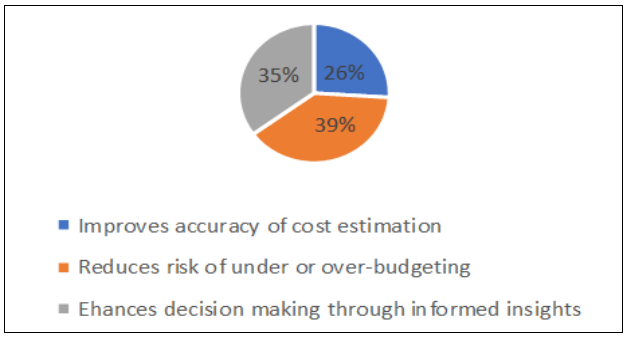

Fig 4.3.2: Effectiveness of expert judgement as a cost estimation technique

The figure above shows that the majority of respondents (39%) indicated that expert judgment as a cost estimation technique reduces the risk of under- or over-budgeting, 35% indicated that it enhances decision making through informed insights, and 26% indicated that it improves the accuracy of cost estimation.

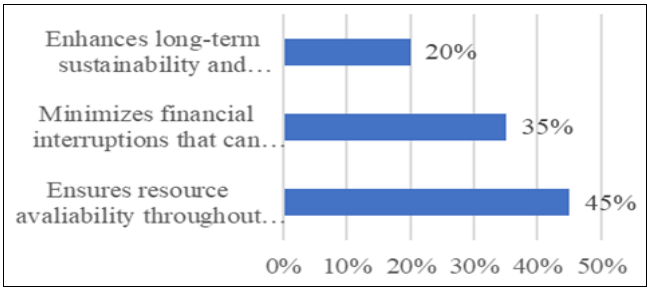

Fig 4.3.3: Effectiveness of financing as a determining budget technique

The figure above shows that the majority of respondents (45%) indicated that financing as a determining budget technique ensures resource availability throughout project execution, 35% indicated that it minimizes financial interruptions that can delay project activities, and 20% indicated that it enhances long-term sustainability and stakeholder trust.

4.4 Objective III: Relationship between Cost Management techniques and Project Performance in the Lusaka-Ndola dual carriageway road construction project

4.4.1 Cost estimation techniques disaggregated by project performance

	Cost estimation techniques							
	Three-point estimation		Top-down estimation		Parametric estimation		Expert judgment	
	N	%	N	%	N	%	N	%
Stakeholder satisfaction	4	24	1	10	5	33	2	25
Scope	8	47	4	40	5	33	2	25
Time	2	12			1	7		
Quality	3	17	5	50	4	27	4	50
Total	17	100	10	100	15	100	15	100

The findings in the table above show that the highest proportion (47%) of respondents indicated that the three-point estimation technique influences the scope during cost estimation in the Lusaka-Ndola dual carriageway, while the least proportion (12%) indicated time. With the top-down estimation technique, the highest proportion (50%) of respondents indicated quality, while the least proportion (10%) indicated stakeholder satisfaction. With parametric analysis, the highest proportion (33%) of respondents indicated stakeholder satisfaction and scope, respectively, while the least proportion (7%) indicated time. With expert judgment, the highest proportion (50%) of respondents indicated quality, and the least proportion (25%) indicated stakeholder satisfaction and scope, respectively.

Table 4.4.2: Determine budget techniques disaggregated by project performance

Determine budget techniques								
	Financing		Expert judgment		Funding limit reconciliation		Cost aggregation	
	N	%	N	%	N	%	N	%
Stakeholder satisfaction	7	35	1	9	2	20	2	25
Scope	5	25	4	33	2	20	4	50
Time	6	30	3	25				
Quality	2	10	4	33	6	60	2	25
Total	20	100	12	100	10	100	8	100

The findings in the table above show that the highest proportion (35%) of respondents indicated that the financing technique influences stakeholder satisfaction during budget determination, while the least proportion (10%) of the respondents indicated quality. With expert judgement, the highest proportion (33%) indicated scope and quality respectively. With funding limitation reconciliation, the highest proportion (60%) of respondents indicated quality, while the least proportion (20%) indicated stakeholder satisfaction and scope, respectively. With cost aggregation, the highest proportion (50%) of respondents indicated scope, while the least proportion (25%) of respondents indicated stakeholder satisfaction and quality.

Table 4.4.3: Cost control techniques disaggregated by project performance

Cost Control techniques								
	Budgeting forecasting		EVM		Value engineering		Lifecycle costing	
	N	%	N	%	N	%	N	%
Stakeholder satisfaction	8	20	7	23	8	35	3	16
Scope	10	26	10	32	9	39	9	47
Time	9	23	14	45				
Quality	12	31			6	26	7	37
Total	39	100	31	100	23	100	19	100

The findings in the table above show that the highest proportion (31%) of respondents indicated that the budget forecasting technique influences quality during cost control of the Lusaka-Ndola dual carriageway construction project, while the least proportion (20%) of the respondents indicated stakeholder satisfaction. With EVM, the highest proportion (45%) indicated time, while the least proportion (23%) indicated stakeholder satisfaction. With value engineering, the highest proportion (39%) of respondents indicated scope, while the least proportion (26%) indicated quality. With life cycle costing, the highest proportion

(47%) of respondents indicated scope, while the least proportion (16%) of respondents indicated stakeholder satisfaction.

4.5 Limitation of cost management techniques in the Lusaka-Ndola dual carriageway road construction project

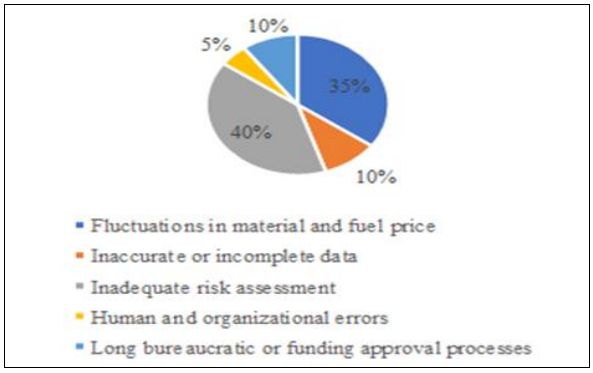

Fig 4.5.1: Limitations of Cost estimation techniques

The study highlights key limitations of cost estimation techniques in the Lusaka-Ndola dual carriageway road construction project. The majority (40%) of respondents indicated inadequate risk assessment as the main limitation, 35% indicated fluctuations in material and fuel prices, 10% inaccurate or incomplete data and long bureaucratic or funding approval processes, respectively, and the least (5%) proportion of respondents indicated human and organization errors.

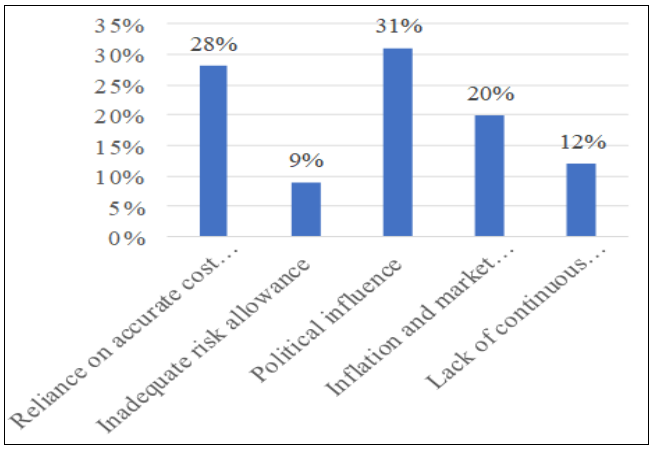

Fig 4.5.2: Limitations of determining budget techniques

The study highlights key limitations of determining budget techniques in the Lusaka-Ndola dual carriageway road construction project. The majority (31%) of respondents indicated political influence as the main limitation, 28% indicated reliance on accurate cost estimation, 20% indicated inflation and market volatility, 12% indicated lack of continuous monitoring and revision of budget, and the least (9%) indicated inadequate risk allowance.

Fig 4.5.3: Limitations of Cost Control techniques

The study highlights key limitations of cost control, 30% of the majority respondent indicated inability to prevent cost overruns,20% of the respondent indicated limited flexibility in responding to changes, 20% of the respondent indicated difficulty in tracking actual costs, 10% of the respondent indicated insufficient data for accurate forecasting, 10% of the respondent indicated limited ability to account for external factors and 10% of the respondent indicated Dependence on timely and accurate reporting.

4.6 Discussion of Findings

The study of cost management techniques employed in the Lusaka-Ndola dual carriageway road construction project reveals a strong reliance on established methods such as, expert judgement and parametric analysis for plan cost management, three-point estimation and parametric estimation for cost estimation, financing and expert judgement for determining the budget and, budget forecasting, earned value management (EVM), and cost-benefit analysis for cost control.

Cost estimation is a fundamental cost management technique used in road construction projects, involving the process of forecasting the total expenses required to complete a project before actual work begins (Ahmed, 2020). This technique plays a critical role in project planning and budgeting by providing a financial blueprint that guides decision-making throughout the project lifecycle. Cost estimation requires a detailed analysis of all components that contribute to the overall cost, including materials, labor, equipment, overheads, and contingency allowances (Del Pico, 2023).

The study requested respondents to indicate the cost estimation technique used in road construction. 35% of the majority of respondents indicated three-point estimation, 30% of the respondents indicated parametric estimation, 20% of the respondents indicated top-down estimation, and 15% of the respondents indicated expert judgement.

It is from cost estimation that the project budget is determined. Budgeting is a critical cost management technique that involves the systematic allocation of financial resources to different activities and phases within a road construction project, based on the initial cost estimates (Hanioglu, 2022). It serves as a financial roadmap, guiding how funds are distributed throughout the project lifecycle to ensure that each component receives adequate funding for

successful completion. Budgeting transforms cost estimates into a structured financial plan that details how much money will be spent, when it will be spent, and on what specific activities, thereby enabling effective financial control and oversight (Jayamaha, 2024).

In this study, the cost management techniques used to determine the budget of the Lusaka-Ndola dual carriageway, results shows that the majority, (40%) of the respondents, indicated Financing, 25% of the respondents indicated expert judgment, 20% of the respondents indicated funding limit reconciliation, and 15% of the respondents indicated Cost aggregation.

Beyond allocation, budgeting provides the foundation for monitoring and controlling project finances. As the project progresses, actual expenditures are recorded and compared against the budgeted amounts (Vigneault, 2020).

This comparison helps identify cost variances, which occur when actual spending deviates from the budget plan. Cost variances can signal issues such as overspending on materials, labor inefficiencies, or unforeseen expenses. By regularly tracking these variances, project managers can take corrective actions early, such as renegotiating contracts, adjusting work methods, or reallocating funds from underutilized activities (Jayamaha, 2024).

With regard to cost control, among the 50 respondents surveyed, 78% reported using budget forecasting regularly, while 62% and 70% applied EVM and cost-benefit analysis, respectively. Value engineering and lifecycle costing were less commonly used, with only 45% and 38% adoption rates. These findings indicate that while conventional techniques are widely embraced, more advanced or specialized approaches remain underutilized. The frequent application of budget forecasting and cost-benefit analysis suggests that project teams prioritize initial planning and financial justification, yet the moderate adoption of EVM points to potential gaps in ongoing monitoring and integration of cost with schedule and scope.

When compared with existing literature, these findings align with global trends where budget forecasting and cost-benefit analysis are foundational to cost management in construction projects (Ahmed 2020). However, the observed rate of EVM adoption in Lusaka is lower than that reported in studies from more developed contexts. For instance, Priyo (2021) notes that EVM is extensively used in regions with mature project management systems due to its ability to integrate cost, time, and scope data.

Objective II: Effectiveness of cost management techniques

Meetings are a commonly used as a plan cost management technique in the Lusaka-Ndola dual carriageway and establishing it effectiveness in project costing, 50% of respondents indicated that meetings as a plan cost management technique reduces conflicts and delays caused by budget misunderstandings, 30% indicated that meetings enhance accountability and transparency and 20% indicated that meetings promote shared understanding of financial constraints and expectations.

The Lusaka-Ndola dual carriageway, being funded by private-public partnerships (PPP), called for a financing technique. This technique involves determining the source and method of securing project funds. It is effective because the majority of respondents (45%) indicated that financing as a determining budget technique ensures resource availability throughout project execution, 35% indicated that it minimizes financial interruptions that can delay project activities, and 20% indicated that it enhances long-term sustainability and stakeholder trust. Financing usually goes hand in hand with funding limit reconciliation because it helps compare planned project expenditures with available funding to ensure that spending aligns with financial constraints. 31% of respondents indicated that funding limit reconciliation as a determining budget technique supports timely completion of project activities, 26% indicated that it encourages efficient use of funds, 23% indicated that it prevents cash flow problems and financial bottlenecks, and 20% indicated that it reduces overruns.

When compared to the literature, these findings are largely consistent with global studies on cost management effectiveness. For example, Hanioglu (2022) emphasizes that effective cost management techniques, such as Earned Value Management (EVM) and proactive budgeting, are essential for minimizing overruns and ensuring project success. The observed effectiveness in Lusaka aligns with this perspective, particularly in terms of budget adherence and variance control. However, the literature also suggests that the effectiveness of these techniques is often influenced by external factors such as economic volatility and regulatory environments (Edet 2024). In Lusaka, issues like inflation and bureaucratic delays were identified as significant barriers, which may explain why some projects still experience cost overruns despite the application of management techniques.

Objective III: Relationship between cost management techniques and project performance

The relationship between cost management techniques and project performance in the Lusaka-Ndola dual carriageway road construction projects was closely interconnected. Cost management techniques were recognized as essential tools that influenced multiple aspects of project performance, including time, quality, scope, and resource utilization (Ahmed, 2020).

Using cross-tabulation tables to highlight the relationship between two variables. To establish the relationship between plan cost management techniques such as meetings and project performance, the findings shows that the highest proportion (63%) indicated stakeholder satisfaction, while the least proportion (37%) indicated time.

Meetings as a plan cost technique ensure that stakeholders are engaged throughout the cost management process. Stakeholder engagement is a critical aspect linking cost management to project performance. Regular reporting and transparent auditing provided stakeholders with clear visibility into project progress and financial status (Markiz, 2022). Literature highlighted that active stakeholder participation, combined with structured cost management practices, contributed to improved project governance and reduced conflicts, ultimately enhancing performance outcomes (Ahmed, 2020).

Disaggregating cost estimation techniques by project performance, the findings shows that the highest proportion (47%) of respondents indicated that the three-point estimation technique influences the scope during cost estimation in the Lusaka-Ndola dual carriageway, while the least proportion (12%) indicated time. With the top-down estimation technique, the highest proportion (50%) of respondents indicated quality, while the least proportion

(10%) indicated stakeholder satisfaction. With parametric analysis, the highest proportion (33%) of respondents indicated stakeholder satisfaction and scope, respectively, while the least proportion (7%) indicated time. With expert judgment, the highest proportion (50%) of respondents indicated quality, and the least proportion (25%) indicated stakeholder satisfaction and scope, respectively.

Cost estimation techniques influence project performance because accurate estimation significantly impacts project performance (28%), reduces overruns (26%), improves timelines (24%), and enhances quality (22%). These findings highlight the importance of effective estimation in achieving project objectives, minimizing risks, and delivering successful outcomes by setting realistic expectations and guiding informed decision-making. However, inaccurate cost estimates can lead to budget shortfalls, rework, or delays in procurement, all of which directly impact project timelines. This is consistent with literature emphasizing that reliable cost estimation is foundational to project planning and execution (Ahmed 2020).

Ensuring that the project budget is within its planned budget, cost control techniques such as Earned Value Management (EVM) directly links financial control with time and scope performance (Priyo, 2021). By integrating cost, schedule, and scope data, EVM enabled project managers to objectively measure performance. These insights allowed timely corrective actions, reducing the likelihood of significant delays or budget overruns (Edet, 2024). For instance, EVM provided performance indices such as the Cost Performance Index (CPI) and Schedule Performance Index (SPI), which allowed managers to identify areas where actual performance deviated from planned objectives (Priyo, 2021).

In this study, EVM was disaggregated by project performance and the findings show that, the highest proportion of respondents (45%) indicated time, while the least proportion (23%) indicated stakeholder satisfaction. With regard to Value engineering, the findings show that, the highest proportion (39%) of respondents indicated scope, while the least proportion (26%) indicated quality.

Value engineering (VE) sought cost-effective alternatives in materials, design, and construction methods without compromising quality (Oyegoke, 2022). For example, substituting traditional materials with more affordable yet durable alternatives reduced costs while improving road longevity. VE promoted efficient resource utilization and enhanced both economic and functional performance of road projects (Priyo, 2021). Literature also highlighted that VE encouraged innovation by challenging conventional practices and identifying opportunities to optimize design and execution processes (Ahmed, 2020). By integrating VE into project planning, contractors were able to reduce unnecessary expenditures, shorten construction timelines, and deliver higher-quality outcomes.

Objective IV: Limitations of cost management techniques

Despite the overall positive assessment, the study identified several limitations that affect the effective usage of cost management techniques in the Lusaka-Ndola dual carriageway road construction project.

Stating the limitations of cost estimation techniques in the Lusaka-Ndola dual carriageway road construction project. The majority (40%) of respondents indicated inadequate risk assessment as the main limitation, 35% indicated fluctuations in material and fuel prices, 10% inaccurate or incomplete data and long bureaucratic or funding approval processes, respectively, and the least (5%) proportion of respondents indicated human and organization errors.

Inadequate risk assessment poses a serious limitation to cost management in road construction projects. Unforeseen circumstances such as natural disasters, floods, landslides, or earthquakes can severely impact road construction activities (Low, 2022). These events may damage ongoing work, disrupt supply chains, or halt construction altogether, leading to extended timelines and additional repair costs. Because such risks are difficult to predict with precision, they are often omitted or underestimated in initial cost plans (Matel, 2022).

Fuel price volatility further disrupted cost control efforts. Road construction relied heavily on fuel for machinery, material transport, and workforce logistics, with prices influenced by global supply-demand dynamics, geopolitical tensions, and market speculation (Hasan, 2021). Sharp increases in fuel costs escalated operational expenses, requiring unplanned budget adjustments. Additionally, bureaucratic delays and permitting requirements extended project timelines and inflated costs. These delays, often arising from government interventions or regulatory reviews, were unpredictable and outside the contractor's control (Alexander, 2025). Extended project durations increased overhead costs and resource utilization, which were inadequately factored into initial budgets.

The study also highlights limitations of cost control techniques in the Lusaka-Ndola dual carriage way road construction project, 30% of the majority respondent indicated inability to prevent cost overruns, 20% of the respondent indicated limited flexibility in responding to changes, 20% of the respondent indicated difficulty in tracking actual costs, 10% of the respondent indicated insufficient data for accurate forecasting, 10% of the respondent indicated limited ability to account for external factors and 10% of the respondent indicated dependence on timely and accurate reporting.

As a cost control technique, EVM faces limitations that hinder its full application in the Lusaka-Ndola dual carriageway project. Indicating the limitation of EVM in the Lusaka-Ndola dual carriageway, 30% of the majority respondent indicated difficulty in measuring progress, 20% of the respondent indicated limited applicability to small projects, 20% of the respondent indicated inability to account for risks, 20% of the respondent indicated complexity in implementation, 20% of the respondent indicated limited visibility into future costs and 10% of the respondent indicated dependence on accurate baseline planning. While limitations of LCC include limited consideration of environmental impacts (40%), ignoring stakeholders (34%), and difficulty predicting long-term costs (26%). These findings highlight the need for a more holistic approach that incorporates environmental and stakeholder factors alongside cost analysis.

Relating the findings to literature, cost control techniques, such as EVM and LCC, were resource-intensive. Implementing these methods required detailed data collection, continuous monitoring, specialized training, and advanced software systems, creating challenges for smaller contractors (Muharremi, 2025; Elsaid, 2025). While these

techniques improved cost control precision and supported decision-making, their complexity limited adoption in firms with restricted resources or technical expertise.

5. Conclusion and Recommendations

Conclusion

The study shows that organizations employ a variety of cost management techniques, with budget forecasting (78%), cost-benefit analysis (70%), and Earned Value Management (EVM, 62%) being the most frequently applied. Value engineering and lifecycle costing are less commonly used but still notable. These practices positively influence decision-making, project quality, team productivity, stakeholder satisfaction, and risk handling. Accurate budgeting and cost estimation further support meeting deadlines and maintaining project standards. Challenges identified include frequent design changes, bureaucratic delays, inflation and fuel price volatility, limited access to real-time financial data, resistance to digital adoption, and inaccurate initial cost estimation. Despite these challenges, contingency planning is generally adequate, showing organizational awareness of potential financial risks.

Recommendations

- Continuous Training and Capacity Building: Ongoing professional development is essential to enhance the skills of project managers, finance teams, and other stakeholders involved in cost management.
- Monitor and Evaluate Cost Management Impact: To ensure cost management practices remain effective, organizations should implement regular monitoring and evaluation mechanisms. Assessing the impact of these practices on project performance, including adherence to budgets, project quality, timeliness, and stakeholder satisfaction.
- Streamline Administrative Procedures: Bureaucratic delays in budget approvals were identified as a significant challenge to effective cost management. Organizations should review and simplify administrative processes to reduce approval timelines.
- Improve Contingency and Risk Planning: Organizations should strengthen contingency measures to address financial risks arising from design changes, market volatility, or unforeseen expenses. Integrating cost risk assessment into project planning ensures that projects remain resilient when unexpected changes occur.
- Strengthen Forecasting and Budgeting Accuracy: Accurate forecasting and budgeting are fundamental to minimizing project overruns. Organizations should adopt structured methods for estimating costs, such as parametric or historical data analysis, and ensure forecasts are regularly updated.
- Invest in Digital Cost Management Tools: Digital tools enhance the ability to monitor budgets, track variances, and allocate resources efficiently. Organizations should invest in robust cost management software that provides real-time data and automated reporting.

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