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Optimizing Project Cost Management for Improved Implementation of Public Electrification Projects: A Case of Kenya Power Last Mile Connectivity in Nyeri County

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Abstract: **The implementation of the Last Mile Connectivity Project by the Kenya Power and Lighting Company in Nyeri County, Kenya, has encountered significant challenges, including low connection rates, project delays, and cost overruns, thereby limiting its effectiveness in expanding electricity access. This study examined the influence of project cost management on the implementation of these projects, focusing on cost estimation, cost budgeting, and cost control.**

The study was anchored on planning theory, the triple constraint theory, and scheduling theory, and adopted a descriptive research design. A census approach was used to include all 67 respondents comprising project managers and project team members. Data were collected using structured questionnaires, with validity and reliability confirmed through pilot testing, construct and content validation, and Cronbach's alpha coefficients. Quantitative data were analyzed using descriptive and inferential statistics, including multiple regression analysis, while qualitative data were analyzed thematically. The findings revealed that project cost estimation ($\beta = 0.512$, $p = 0.004$), cost budgeting ($\beta = 0.362$, $p = 0.002$), and cost control ($\beta = 0.281$, $p = 0.003$) all have a statistically significant positive effect on project implementation. Cost estimation emerged as the strongest predictor, highlighting the importance of accurate forecasting and contingency planning. The study concludes that effective cost management enhances resource allocation, minimizes delays, improves financial accountability, and strengthens stakeholder trust, thereby improving implementation outcomes. The study recommends enhanced stakeholder engagement during planning, adoption of robust cost monitoring systems, integration of risk management frameworks, and comprehensive upfront budgeting to improve project performance. These findings contribute to the understanding of cost management practices in public electrification projects and provide practical insights for improving implementation efficiency.

Keywords: **Project Cost Management, Project Implementation, Cost Estimation, Last Mile Connectivity, Rural Electrification.**

1. INTRODUCTION

The growing global demand for energy driven by population expansion and industrialization has intensified the need for efficient and sustainable project implementation within the energy sector. Effective execution of energy projects is essential not only for meeting rising consumption needs but also for advancing economic growth, innovation, and environmental sustainability (Mihic et al., 2019; Pieterse, Cheung & Yunusa-Kaltungo, 2024). In this context, project cost management has emerged as a critical determinant of project success, influencing financial performance, operational efficiency, and long-term sustainability of energy initiatives (Alhoweish, 2021). Given the dynamic nature of the sector—characterized by regulatory shifts, technological advancements, and volatile market conditions—project managers must adopt adaptive cost management practices to ensure project viability (Kozhakhmetova & Anarkhan, 2024).

Globally, energy project implementation presents varied experiences. For instance, Germany's renewable energy transition has achieved significant expansion in wind and solar capacity, although challenges such as grid stability persist (Matthes, 2022). Similarly, China has demonstrated global leadership in solar energy deployment through large-scale investments and production capabilities (Tahir et al., 2023). In Africa, countries such as Nigeria and South Africa are investing heavily in renewable energy and distribution infrastructure to improve electricity access and diversify energy sources (Ogundari & Otuyemi, 2019; Mkhize & Nel-Sanders, 2023). These experiences underscore the importance of efficient project management practices, particularly cost management, in achieving successful implementation outcomes.

In Kenya, the energy sector has made notable progress, particularly in geothermal energy development and expansion of electricity access through large-scale projects (Ndile, 2021; Njoka & Gikonyo, 2023). Among these initiatives is the Last Mile Connectivity Project (LMCP), implemented by the Kenya Power and Lighting Company, which aims to enhance electricity access in rural and underserved areas. Despite its strategic importance, the project has encountered implementation challenges, including delays, cost overruns, and suboptimal connectivity rates (KPLC Report, 2024). These challenges highlight potential inefficiencies in project cost management practices.

Project implementation refers to the structured execution of planned activities to achieve defined objectives within specified time, cost, and quality parameters (Al-Hajj & Zraunig, 2021; Shi, 2021). Successful implementation requires effective coordination, communication, and resource allocation, as well as continuous monitoring and evaluation (Slevin & Pinto, 2020; Finch, 2023). However, multiple factors including resource availability, stakeholder engagement, regulatory environments, and financial management can significantly influence project outcomes (Hellgren & Stjernberg, 2020; Hacker & Doolen, 2023).

Project cost management, on the other hand, encompasses cost estimation, budgeting, and control processes aimed at ensuring projects are completed within approved financial limits (Smith, 2022; Liu et al., 2023). Accurate cost estimation enhances planning and procurement decisions, while effective budgeting promotes accountability and resource optimization (Doloi, 2021; Chan & Park, 2023; Klakegg & Lichtenberg, 2020). Moreover, robust cost control mechanisms enable early identification of financial risks, reducing the likelihood of cost overruns and improving overall project performance (Taylor, 2022; Pajares & Lopez-Paredes, 2023).

Despite existing empirical evidence linking cost management to project success, prior studies in Kenya—focusing on sectors such as health, housing, and road infrastructure have largely reported contextual and conceptual limitations (Omukuba & Muchelule, 2022; Chepkwony et al., 2023; Obuo & Nyang'au, 2024). Specifically, there is limited research examining the direct influence of cost management practices on the implementation of public electrification projects at the county level. Against this backdrop, the present study addresses this gap by examining how project cost management practices namely cost estimation, budgeting, and control affect the implementation effectiveness of Last Mile Connectivity Projects in Nyeri County, Kenya. By focusing on a critical national electrification initiative, the study contributes to both theory and practice by providing context-specific insights into optimizing cost management for improved project implementation outcomes.

2. LITERATURE REVIEW

The theoretical foundation of this study is anchored on three complementary perspectives; planning theory, the triple constraint theory, and scheduling theory which collectively provide a comprehensive explanation of how project cost management influences implementation outcomes. Planning theory, originally advanced by Patrick Geddes, emphasizes participatory and context-sensitive decision-making that integrates social, economic, and environmental dimensions in project planning (Geddes, 1915). Contemporary interpretations extend this perspective by underscoring the importance of spatial justice and inclusivity, arguing that effective planning must address socio-economic inequalities and ensure equitable access to resources (Friedmann, 2018). Furthermore, modern critiques advocate for adaptive and flexible planning approaches capable of responding to uncertainty and dynamic environments (Hudson, Galloway & Kaufman, 2021). Within the context of rural electrification projects, planning theory highlights the necessity of stakeholder engagement, continuous evaluation, and contextual responsiveness to enhance implementation effectiveness.

The triple constraint theory, introduced by Dr. Martin Barnes, provides a fundamental framework for understanding project performance through the interdependent relationship between scope, time, and cost (Barnes, 1984). The theory posits that any change in one constraint inevitably affects the others, thereby requiring project managers to maintain a careful balance

to achieve desired outcomes (Josiah, 2019). Recent extensions of the theory incorporate additional dimensions such as quality and stakeholder satisfaction, offering a more holistic perspective on project success (Hassan, Adeleke & Taofeeq, 2022). This theoretical lens is particularly relevant to public electrification initiatives, where inefficiencies in cost management often manifest in delays, scope variations, and compromised service delivery. Complementing these perspectives, scheduling theory—developed by George Dantzig provides a structured and mathematical approach to optimizing resource allocation and task sequencing over time (Dantzig, 1956). Advances in this theory emphasize the use of algorithmic optimization techniques to minimize completion time and maximize resource utilization (Chretienne et al., 2018). Additionally, the theory incorporates human and organizational considerations, recognizing the importance of flexibility in scheduling decisions to enhance productivity and efficiency (Buxey, 2019; Herroelen, 2022). In infrastructure projects such as electrification, scheduling theory is instrumental in ensuring effective coordination of labor, materials, and equipment, thereby supporting timely and cost-efficient project implementation.

Empirically, existing literature demonstrates a strong relationship between project cost management practices particularly cost estimation, budgeting, and control and project implementation outcomes, although significant contextual gaps remain. Studies on cost estimation consistently highlight its critical role in enhancing project performance. For instance, Egboga, Daniel, and Abubakar (2022) found that accurate cost estimation positively influences project outcomes in construction firms by improving alignment between scope, time, and cost parameters. Similarly, Tumwesigye and Mulyungi (2019) reported a strong positive relationship between cost management and project implementation in Rwanda, while Kimotho, Nyangau, and Muchelule (2024) established a statistically significant association between cost estimation and performance of sports infrastructure projects in Kenya. However, these studies are largely sector-specific, limiting their generalizability to public electrification projects.

With regard to cost budgeting, empirical findings present mixed results. Njeru (2022) found that budgeting practices had an insignificant effect on the performance of government-funded projects in Nairobi, suggesting inefficiencies in budget execution. Conversely, Uwiragiye and Mulyungi (2019) demonstrated that poorly defined or inadequately implemented budgets negatively affect project success due to constraints in resource allocation. Further, Murei, Kidombo, and Gakuu (2021) emphasized the importance of allocating adequate resources for monitoring and evaluation, noting that well-structured budgets significantly enhance project performance. Nonetheless, these studies are primarily concentrated in sectors such as water and agriculture, thereby limiting their applicability to electrification projects.

In contrast, empirical evidence on cost control consistently underscores its importance in achieving successful project outcomes. Bichang and Kimutai (2024) found that cost control strategies—including accurate forecasting, continuous monitoring, and evaluation—significantly improve project performance in water development initiatives. Similarly, Theophilus and Gichuhi (2020) established a positive and significant relationship between cost control practices and successful completion of road construction projects. Wanjau, Namusonge, and Lango (2024) further confirmed that cost planning and control positively influence housing project performance. Despite these consistent findings, the majority of these studies are concentrated within construction and infrastructure sectors, with limited focus on electrification projects and broader implementation indicators such as service coverage and quality.

3. RESEARCH METHODOLOGY

This study employed a descriptive research design to examine the influence of project cost management on implementation outcomes. Such a design provides a structured framework for systematically collecting and analyzing data to identify patterns and relationships without manipulating variables (Kothari, 2004). The target population comprised 67 personnel from the Kenya Power and Lighting Company in Nyeri County, including project managers and project team members involved in the Last Mile Connectivity Projects. Given the small population size, a census approach was adopted to include all respondents, thereby enhancing representativeness and eliminating sampling error (Ritchie, Tennant & Rahim, 2022).

Data were collected using a semi-structured questionnaire with both open- and closed-ended items organized around cost estimation, cost budgeting, cost control, and project implementation. A five-point Likert scale was used for quantitative responses. A pilot study involving 10% of the sample was conducted to test the instrument. Validity was ensured through construct and content validation, while reliability was confirmed using Cronbach's alpha coefficients, all of which exceeded the acceptable threshold of 0.7 (Amirrudin, Nasution & Supahar, 2021). Data collection followed formal procedures, including obtaining approvals from relevant authorities and administering questionnaires to respondents, which were later collected after follow-up. Quantitative data were analyzed using descriptive statistics (means and standard deviations) and

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inferential statistics (multiple regression analysis), while qualitative data were analyzed thematically. The regression model examined the relationship between cost estimation, budgeting, and control on project implementation at a 95% confidence level.

Ethical standards were upheld by ensuring informed consent, confidentiality, and the secure handling of all respondent information.

4. RESEARCH FINDINGS AND DISCUSSIONS

4.1 Descriptive Statistics

The descriptive results indicate a generally positive perception of project cost management practices and their influence on implementation outcomes within the Kenya Power and Lighting Company Last Mile Connectivity Projects in Nyeri County.

4.1.1 Project Cost Estimation

Table 4.1: Project Cost Estimation

Statements	SD %	D%	N%	A%	SA%	M	St.Dev
Accurate initial estimates enable effective resource allocation	26.9	20.5	14.1	21.8	16.7	3.53	1.468
Accurate estimates improve planning and timely delivery	2.6	1.3	0.0	25.6	70.5	3.68	1.320
Resource cost estimates improve efficiency	11.4	12.9	5.7	37.1	32.9	3.67	1.359
Cost estimates enhance communication and collaboration	9.1	13.2	5.8	43.6	28.4	3.82	1.160
Contingency allocation minimizes financial risks	5.5	3.4	7.4	28.3	55.5	4.25	1.062
Contingency improves planning accuracy	5.4	3.4	7.4	32.2	51.4	4.22	1.070
Overall score	**10.2**	**9.1**	**6.7**	**31.4**	**42.6**	**3.86**	**1.239**

Overall (M = 3.86), respondents agreed that cost estimation significantly enhances implementation through improved planning, resource allocation, and risk mitigation. This aligns with prior findings (Egboga et al., 2022; Tumwesigye & Mulyungi, 2019).

4.1.2 Project Cost Budgeting

Table 4.2: Project Cost Budgeting

Statements	SD %	D%	N%	A%	SA%	M	St.Dev
Budget allocation enhances resource optimization	3.8	8.9	0.0	62.8	24.4	4.31	0.690
Budgeting supports financial forecasting	10.9	8.1	2.9	44.9	33.1	4.18	0.820
Planned value provides performance baseline	0.0	7.7	0.0	55.1	37.2	4.51	0.490
Budgeting improves stakeholder communication	10.7	13.7	2.8	26.3	45.5	4.11	0.890
Budget flexibility supports adaptability	2.6	1.3	0.0	25.6	70.5	3.68	1.320
Flexible budgeting enhances stakeholder confidence	11.5	5.1	0.0	38.5	44.9	4.27	0.730
Overall score	**6.6**	**7.5**	**0.9**	**42.2**	**42.6**	**4.18**	**0.823**

Cost budgeting recorded the highest mean (M = 4.18), indicating strong agreement on its role in enhancing implementation through efficient allocation, forecasting, and flexibility. This contrasts with Njeru (2022) but supports Uwiragiye and Mulyungi (2019).

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4.1.3 Project Cost Control

Table 4.3: Project Cost Control

Statements	SD %	D%	N%	A%	SA%	M	St.Dev
Cost reporting enhances transparency	10.9	8.6	6.2	35.8	38.6	3.45	1.546
Cost reporting aids performance evaluation	6.7	10.1	15.7	37.1	30.3	3.74	1.260
Audits reduce inefficiencies	7.3	8.0	11.4	28.9	44.4	3.94	1.056
Compliance fosters accountability	7.9	9.2	12.7	33.7	36.5	3.90	1.096
Procurement control enhances budget adherence	15.8	14.5	3.6	38.8	27.3	3.85	1.170
Procurement control improves supplier relations	6.2	2.6	5.9	26.6	60.3	4.28	0.725
Overall score	**9.1**	**8.8**	**9.3**	**33.5**	**39.6**	**3.86**	**1.142**

Respondents (M = 3.86) acknowledged that cost control enhances transparency, accountability, and efficiency. These findings are consistent with Bichang and Kimutai (2024).

4.1.4 Project Implementation

Table 4.4: Project Implementation

Statements	SD %	D%	N%	A%	SA%	M	St.Dev
Adherence to project scope	3.4	2.2	6.7	34.8	52.8	3.06	1.940
High-quality deliverables	9.1	8.8	9.3	33.5	39.6	3.86	1.142
Increased customer connections	3.4	6.7	6.7	28.1	55.1	4.21	0.790
Increased revenue collection	6.7	9.0	22.5	31.5	30.3	3.70	1.299
Overall score	**5.6**	**6.7**	**11.3**	**31.9**	**44.5**	**3.71**	**1.293**

Implementation outcomes were positively rated (M = 3.71), particularly in customer connectivity and service delivery, aligning with Slevin and Pinto (2020) and Finch (2023).

4.2 Regression Analysis

Table 4.5: Model Summary

R	R Square	Adjusted R Square	Std. Error	R
0.891	0.794	0.723	0.578	0.891

The model explains **72.3%** of variation in project implementation, indicating strong explanatory power.

Table 4.6: ANOVA

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	99.081	3	33.027	62.325	0.003
Residual	31.265	59	0.529		

The model is statistically significant ($p = 0.003 < 0.05$).

Table 4.7: Coefficients

Variable	B	Std. Error	Beta	t	Sig.
Constant	0.528	0.251		2.104	0.002
Cost Estimation	0.706	0.311	0.512	2.270	0.004
Cost Budgeting	0.791	0.295	0.362	2.681	0.002
Cost Control	0.734	0.164	0.281	4.476	0.003

All variables significantly influence implementation ($p < 0.05$), with **cost estimation having the strongest effect**, followed by budgeting and control. These findings align with Kimotho et al. (2024), Murei et al. (2021), and Wanjau et al. (2024).

4.3 Qualitative Findings

Thematic analysis reinforces quantitative results. Respondents emphasized that accurate cost estimation improves resource allocation and reduces delays, effective budgeting enhances monitoring and prevents financial constraints, while cost control ensures prioritization of critical activities and minimizes overruns. Overall, cost management practices were perceived as essential for improving efficiency, transparency, and successful implementation of electrification projects.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study establishes that effective project cost management significantly enhances the implementation of electrification projects undertaken by the Kenya Power and Lighting Company. Specifically, accurate cost estimation improves resource allocation, facilitates realistic scheduling, and enables early identification of potential financial adjustments, thereby supporting timely and efficient project execution. Additionally, transparent financial planning fosters stakeholder trust and engagement, which is critical for successful project delivery.

The findings further demonstrate that effective cost budgeting contributes to improved implementation by ensuring timely availability of resources, minimizing delays, and enhancing financial predictability. Proper budget structuring enables project managers to align actual expenditures with planned allocations, thereby improving decision-making and operational efficiency.

Moreover, the study concludes that cost control plays a critical role in maintaining projects within budget while optimizing resource utilization. Effective cost control mechanisms enhance financial discipline, enable early detection of risks, and strengthen stakeholder confidence, including community acceptance, which is essential for successful implementation of public electrification projects.

5.2 Recommendations

The study recommends that project implementers strengthen stakeholder engagement during the planning phase to ensure that cost estimates and budgets reflect local realities. Establishing robust monitoring and evaluation systems is also essential to track cost performance and identify discrepancies early.

Further, the adoption of comprehensive risk management frameworks is recommended to improve contingency planning and financial resilience. Leveraging technology for real-time data collection on costs, materials, and labor can enhance decision-making accuracy and responsiveness.

Additionally, organizations should prioritize comprehensive upfront budgeting, regular financial reviews, and transparent reporting mechanisms. Strengthening supplier relationships and adopting competitive procurement processes are also critical for achieving cost efficiency and maintaining budget discipline.

5.3 Suggestions for Further Research

The study identifies that 27.7% of variation in project implementation is explained by factors beyond cost estimation, budgeting, and control. Future research should therefore explore additional project management dimensions influencing implementation outcomes. Furthermore, comparative studies across different sectors are recommended to enhance generalizability and deepen understanding of cost management practices in diverse project environments.

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