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Research Article

Evaluating the Effectiveness of Quality Control Measures in Project Management: A Study of Construction Companies in Lusaka

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About Article

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ABSTRACT

Quality control measures implemented in project management functions of construction companies function as essential elements which support project achievement, client fulfillment, and business endurance. Effective quality control mechanisms help identify and fix errors in advance as well as uphold industry standards and regulations to deliver project outputs that fulfill requirements and client needs. Operationally strong quality control systems decrease the expenses associated with costly project rework and project delays and resource wastage to enhance both budgetary efficiency and schedule performance. The main purpose of this study was to evaluate how well quality control methods perform in construction project oversight at Lusaka-based companies. The investigation employed a cross-section survey allowing the use of quantitative statistical analysis. Primary data was gathered from 50 construction companies using a structured questionnaire consisting of closed-ended questions. Chi-square analysis revealed relationships between different groups of variables while binomial and multinomial statistical methods measured binary and multidimensional success rates. The findings demonstrated that quality control was assessed to be effective by 56.4% of participants but delayed projects for 43.6% due to quality issues which proved crucial for project time management. The research data showed that quality control effectiveness creates a statistically significant link with project delays (Chi-Square $p < 0.05$). The study revealed poor quality audit practices among participants. Quality control measures led to decreased rework according to 81.8% and 78.2% expressed high satisfaction with project quality when quality control measures are implemented. A majority of 63.6% of respondents implemented technology-based quality control solutions which shortened project while reducing project expenses and delivering improved project quality. A solid positive relationship appeared between how well technology supports quality control and general quality control practices (Pearson coefficient = 0.893). Quality control measures improve the efficiency of construction projects, but they should be further improved as many projects still get delayed as a result of quality issues. However, regular audits could be improved, and also management support could be better. Therefore, to have better quality control in the organizations, investment should be made in employee training, adoption of the latest technologies, frequent audits, enough resource allocation, bottlenecks and delays, updates on quality processes, leadership commitment, and employee involvement in order to address these areas.

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1. INTRODUCTION

1.1. Background

Quality assurance becomes an essential determinant of quality control in the entire spectrum of project management specifically within the construction industry, because it is the very basis upon which project success is mounted (Harris, 2022). Quality control procedures are among the very top evasion means of doing defect identification and correction at an early project life cycle; maintaining circulation with industry standards and regulations; and ensuring that the project's deliverables are met with the overall requirements and expectations (Rashed, 2014). Effective quality control minimizes the risks of costly reworking, provides project delays, and wastage of resources while optimizing time and budget. This has made a very significant contribution to overall project success (Damane, 2022).

The global construction industry has, in recent years, witnessed a total transformation and a movement toward quality-focused approaches. Many companies have consequently integrated international best practices and standards to improve outcomes of their projects (Rwelamila, 2023). On a more local level, Lusaka's construction industry has rapidly grown and developed with an accompanying demand for increased infrastructure projects, hence the need for much more stringent quality control measures for timely and within budget delivery of good quality (Cheelo & Liebenthal, 2020). This study, by identifying some of the key quality control practices, analyzing their implementation and effects on project outcomes, and determining those factors that are influential to the success of these practices, sought to illuminate ways in improving the quality of construction projects in the region.

1.2. Statement of the problem

The construction industry in Lusaka is faced with the serious drawbacks of not realizing the efficacy of quality control measures in project management (Aigbavboa *et al.*, 2018). Even where these quality control practices were affected, there has always been found a discrepancy between intended and realized outcomes, leading to project delays and cost overruns, while quality remained compromised. Recent local statistics indicate that 40% of construction projects in Lusaka are subject to delays as an outcome of quality issues, thus causing huge financial losses to the companies involved and dissatisfaction to the clients (Kawimbe *et al*, 2024). This discrepancy in the application of quality controls within the construction organizations working in Lusaka calls for prompt intervention.

1.3. General objectives

To assess the effects of quality control measures on construction companies in Lusaka regarding project management.

1.3.1. Specific objectives

i. To measure how quality control measures, affect project performance in Lusaka construction companies.

ii. To analyze the influencing elements of successful quality control measures in construction project management within Lusaka.

iii. To measure the effectiveness of real-time data analytics in contributing to better decision-making in quality control with construction companies in Lusaka.

iv. To evaluate the constraints in the implementation of effective quality control measures in project management for construction companies in Lusaka.

1.4. Conceptual framework

Within construction companies in Lusaka, this study attempted to assess how effective quality control measures were in project management using a conceptual framework. On this account, the framework established the critical independent variables of quality control measures, namely compliance with industry standards, personnel training, inspections of material quality, process monitoring, technology-enabled quality tools, supplier and contractor management, and customer feedback mechanisms (Worlu *et al.*, 2019). Meanwhile, project management practices, organizational culture, and resource allocation act as crucial mediating variables that determine the effective application and integration of these quality control measures with each project.

2. LITERATURE REVIEW

2.1. Effect of quality control measures on project outcomes among construction companies.

The most basic cost-efficient aspect of quality control measures is ensuring that the construction material is as per the required standard (Allen, 2019). Companies can avoid these costs by checking the quality of materials ex-ante, hence eliminating other costs related to replacement/defect repair after the project onwards (Egwunatum *et al.*, 2022).

By identifying and correcting faults early, they can avoid delays caused by such problems being found later on in the project. Quality control saves time by providing that the materials and workmanship meet the required specifications from the start (Gökçeoğlu & Sözer, 2021).

The aspect of a successful construction industry is client satisfaction, and the same is largely determined by the quality of work done. The outcomes of construction projects meet and exceed expectations following high-quality construction work, thus satisfied clients are most likely to return for more and give referrals (Mellado *et al.*, 2020).

2.2. Factors influencing the success of quality control measures in project management within construction companies.

Without leadership commitment, then the quality assurance scheme would be doomed in any construction project management application. If top management provides its attention to and support for quality control activities, the company gets the signal that quality is a major organizational value (Uyanwatta, 2024).

Moreover, the leadership commitment at every level plays a critical role and ensures the proper allocation of resources to quality control efforts (Damane, 2022). These include providing training and education to employees, investing in quality control technology and tools, it also involves the allocation of enough time and manpower to carry out activities related to quality control. In the absence of top-management support,

such efforts will typically be underfunded or understaffed, thereby rendering them ineffective (Ofori, 2008).

Abdullahi investigated quality management practices in Nigerian construction firms with the intention of providing recommendations for improvement in quality performance. Inspections and statistical quality control techniques are found in this study to be the most commonly applied quality management instruments by Nigerian construction firms (Abdullahi *et al.*, 2019).

Evaluation of construction quality management heavily marshals by comparison to total quality management principles (Adusa-Poku, 2015). The results from the analyses indicate that inspection and quality control occupy the top position among quality management practices in Ghana. Process management, continuous improvement, employee satisfaction/empowerment, supply chain management, customer focus, management/leadership commitment, and training rank in importance as success factors for TQM (Adusa-Poku, 2015).

2.3. Real-time data analytics in enhancing quality control decision-making among construction companies

The analytics, through which data may be accessed instantly, serve as a crucial element in the construction companies recognizing the possible quality-related deficiencies much early in the life cycle of the project and avoiding costly errors and rework (Femi, 2015). For long, the traditional form of quality control has depended on a purely preventive-reactive manual approach based on infrequent checks and inspections. Therefore, delays in recognizing defects and higher costs and overruns in the project are prevalent. The emergence of real-time data analytics, however, provides room for construction firms to adopt a more proactive stance in addressing quality issues as they arise (Jackson, 2020).

Moreover, real-time data analytics could be coupled with drones and other remote sensing technologies for doing aerial treasures. Drones fitted with high-end cameras and equipped with thermal imaging efficacy can help capture images of construction sites and identify defects such as cracks, leaks of water, or structural weakness that may not actually be seen by humans. On this capability, real-time data analytics can thus change the quality checker in a construction company from a reactive to a proactive stance to avoid defects and reworks costs and time wastage in buildings (Memon *et al.*, 2013).

2.4. Barriers to implementing effective quality control measures in project management within construction companies

Construction projects, mainly those run by smaller companies or restricted funding, have always had to grapple with the financial burden of quality control measures (Harris *et al.*, 2021). These costs comprise procurement or lease of sophisticated software and equipment such as laser scanners, concrete testing kits, and structural analysis tools (Tambare *et al.*, 2021).

Quality control applies much to building at a high level of the standardized quality material, which would be expected to meet safety and performance demands (Harris *et al.*, 2021). Companies with little resources will often go for cheaper materials, which might help save upfront costs but are not always up to standard quality. Such is the case where most quality problems lead to reworks and hence more use of materials and ultimately increased costs over time. Further, the prices of materials vary and supplies may also experience some disruptions, which would make it that much more difficult for companies to maintain quality control by simply being tied to one standard of materials throughout the project (Bahia, 2023).

3. METHODOLOGY

The research adopted a cross-sectional survey design, with a quantitative approach for the collection and analysis of primary data. The target population for the study was the construction companies in Lusaka.

In total, 50 construction companies in Lusaka participated in the study. A convenience sampling approach was used to select the study sample. Data was mainly collected via face-to-face interviews, complemented by electronic questionnaires filled on the research variables. The main data collection method employed in this study was the structured questionnaire composed of closed-ended questions.

Statistical Package for the Social Sciences (SPSS) version 26 was used for data entry and statistical analysis. The chi-square test was used to determine associations between categorical variables.

4. RESULTS AND DISCUSSION

4.1. Presentation of results on background characteristics of the respondents

There were more men than women among the participants: 67.3% (37 participants) identified as men and 32.7% (18 participants) as women. The largest proportionate age group was 26-30 years old, comprising 36.4% (20 participants) of total participants, while the 36-40 and above-40 age groups each represented 21.8% (12 participants). The 31-35 age group accounts for 20.0% (11 participants) of our sample. Most participants in the study were married, accounting for 67.3% (37 participants) of total participants. Most of the participants held educational qualifications at the Bachelor's Level since 67.3% (37 participants) belonged to that category. A Master's degree was held by 21.8% (12 participants), while 10.9% (6 participants) held a Higher Education Diploma.

4.2. The impact of quality control measures on project outcomes in construction

A combined 43.6% of participants rated the quality control measures as either "Very Ineffective" or "Ineffective,". Conversely, 56.4% found the measures to be "Effective" or "Very Effective,".

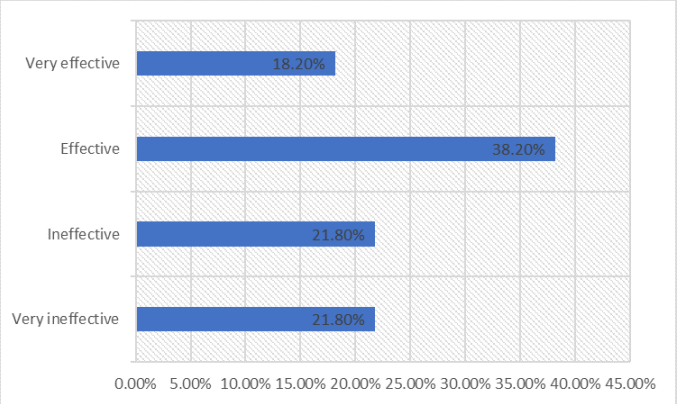

Figure 1. Participant's perception on the quality control measures on project outcomes in construction

Nearly half of the respondents (43.6%) have encountered project delays attributed to quality issues within the past year.

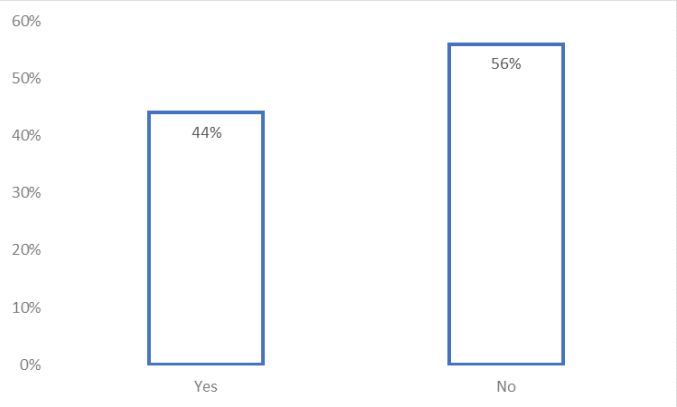

Figure 2. Occurrence of project delays due to quality control measures

The Chi-Square test results showed a significant relationship between the effectiveness of quality control measures and the experience of project delays due to quality issues in construction projects. A project with effective quality control measures is encounters less delays compared to one without affective measures.

Table 1. Association between quality control effectiveness and project delays in construction

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

a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 4.36.

Only 27.3% of participants conduct quality audits regularly, while a significant 32.7% never perform audits. Combined, 60% of respondents either rarely or never conduct quality audits.

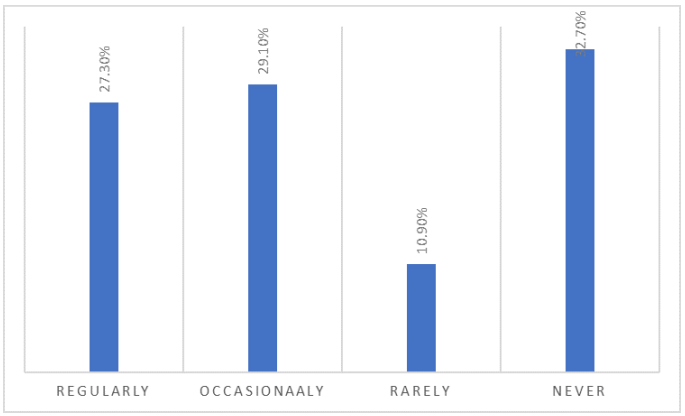

Figure 3. Frequency of conducting quality control audits

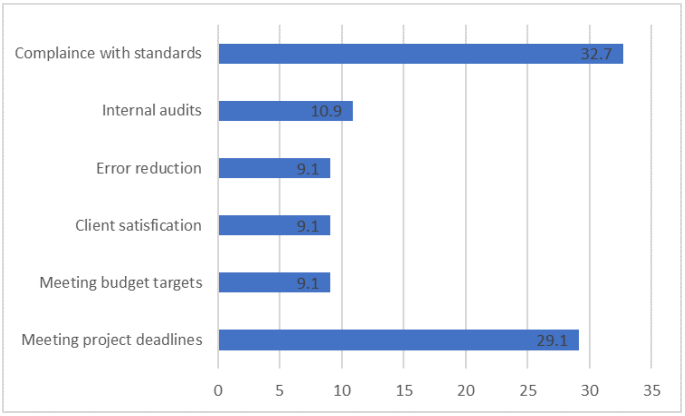

Figure 4. Common metric for assessing quality control success

Similar to project delays, 44.0% of respondents have received client complaints concerning quality issues in the past year.

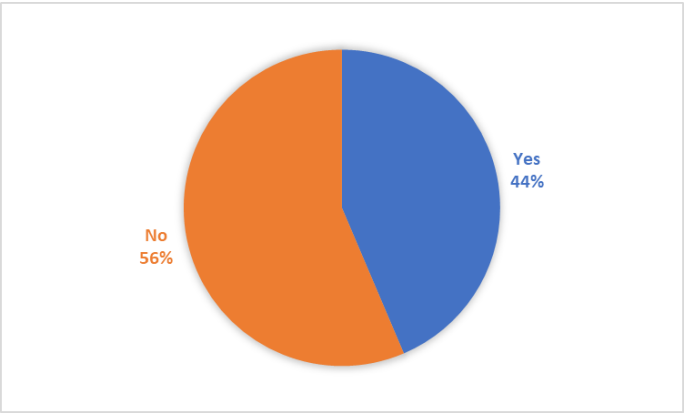

Figure 5. Occurrence of project delays

A dominant 56.4% of participants believe that effective quality control measures significantly contribute to project success, while 32.7% view the contribution as moderate. Only 10.9% consider the impact to be somewhat.

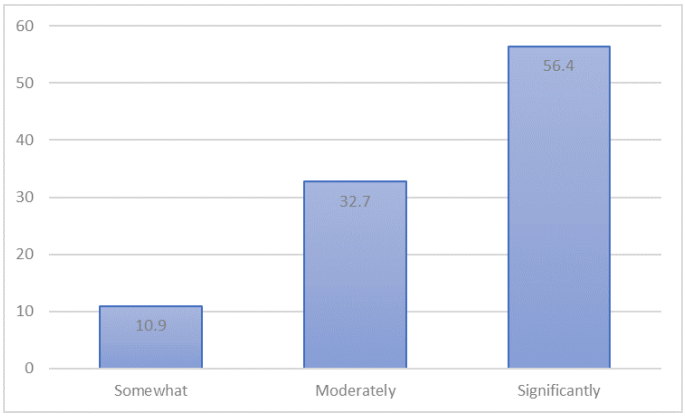

Figure 6. Participant's perception on the effect of effective quality control measures significantly contribute to project success

The results revealed a significant relationship between the belief in the effectiveness of quality control measures and the frequency of reviewing and updating these measures. Companies that perceive that quality control measures are important tend to review their measures frequently.

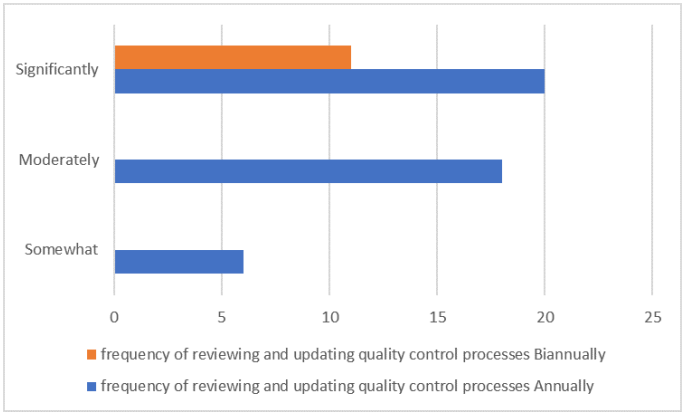

Figure 7. Chi-square analysis of the relationship between belief in quality control effectiveness and frequency of quality control reviews

A majority of respondents (56.4%) are "Very Satisfied" with the overall quality of their construction projects, and an additional 21.8% are "Satisfied." Together, 78.2% express positive satisfaction levels, while the remaining 21.8% maintain a neutral stance.

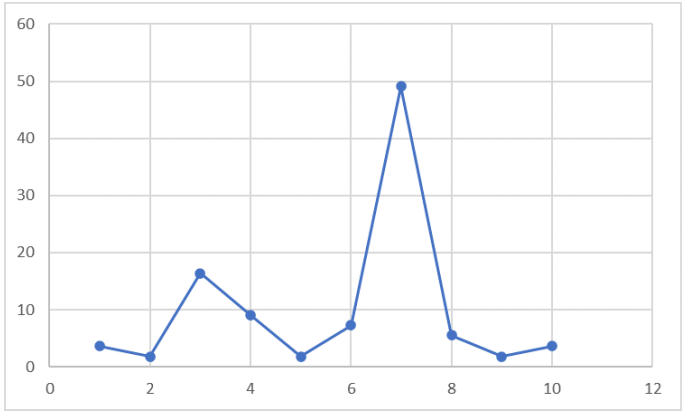

Figure 8. Rating effectiveness of quality control measures on a scale of 1-10

4.3. Factors influencing the success of quality control measures in project management within construction companies

The most significant challenge identified by participants is a lack of resources (40%), followed by poor communication (20%) and lack of employee training (18.2%). A smaller percentage noted challenges like resistance to change and data management (10.9%) respectively. A majority of respondents (43.6%) believe that senior management support is very important for the success of quality control measures, with another 27.3% rating it as moderately important. Only a small portion (9.1%) sees it as not important.

Most researchers pointed out lack of resources (40%); next, the contributing factors in limiting the quality control measures are poor communication (20%) and lack of employee training (18.2%). Change resistance and data management were listed by lesser percentages (10.9%) in turn on the questionnaire. A majority of respondents (43.6%) believe that senior management support is very important for the success of quality control measures, with another 27.3% rating it as moderately important. Only a small portion (9.1%) sees it as not important.

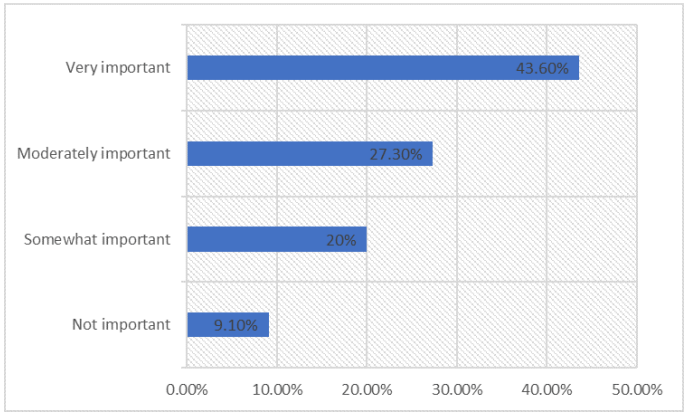

Figure 9. Participant's perception on the importance of senior management support for the success of quality control measures

When dealing with deviations from quality control standards, the majority (69.1%) prefer immediate corrective action, while 20% opt for a reassessment of quality control measures. Only a small portion (10.9%) consider project suspension for re-evaluation.

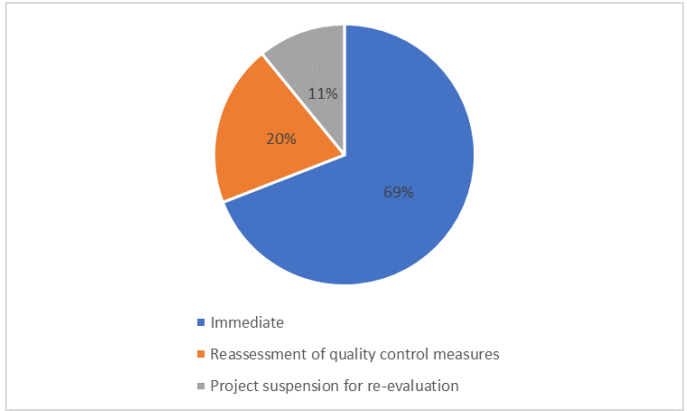

Figure 10. Measures for deviations from quality control standards

4.4. Effectiveness of real-time data analytics in enhancing quality control decision-making among construction companies in Lusaka

The majority of respondents (85.5%) agreed that real-time data analytics enhances early identification of quality issues. Furthermore, an overwhelming 76.4% of participants strongly agreed that real-time data analytics aids in making more precise quality control decisions, while an additional 9.1% agreed. This shows a high level of confidence in the accuracy improvements brought by these technologies. However, a minority (23.7%) were either neutral or disagreed.

Table 2. The use of real-time data analytics helps in making more accurate quality control decisions on construction sites.

		Frequency	Valid Percent	Cumulative Percent
	Disagree	4	7.3	7.3
	Neutral	9	16.4	23.6
Valid	Agree	5	9.1	32.7
	Strongly agree	37	67.3	100.0
	Total	**55**	**100.0**	

A substantial 85.5% of respondents agreed that access to real-time data boosts the efficiency of quality control, with nearly half (49.1%) agreeing and 36.4% strongly agreeing.

Table 3. Access to real-time data has increased the overall efficiency of quality control activities on our construction projects.

		Frequency	Valid Percent	Cumulative Percent
	Disagree	4	7.3	7.3
	Neutral	4	7.3	14.5
Valid	Agree	27	49.1	63.6
	Strongly agree	20	36.4	100.0
	Total	**55**	**100.0**	

There is strong agreement (100%) among participants that real-time data analytics has lessened the dependence on manual inspections, with 54.5% strongly agreeing.

Table 4. The insights provided by real-time data analytics have reduced the reliance on manual inspections for quality control.

		Frequency	Valid Percent	Cumulative Percent
	Agree	25	45.5	45.5
Valid	Strongly agree	30	54.5	100.0
	Total	**55**	**100.0**	

The responses were largely positive, with 85.5% of participants agreeing that real-time data analytics aids in forecasting potential quality issues, thereby enabling proactive measures. A small percentage (14.6%) were either neutral or disagreed.

Table 5. The use of real-time data analytics helps in predicting potential quality issues before they occur on the construction site.

		Frequency	Valid Percent	Cumulative Percent
	Disagree	4	7.3	7.3
	Neutral	4	7.3	14.5
Valid	Agree	27	49.1	63.6
	Strongly agree	20	36.4	100.0
	Total	**55**	**100.0**	

Every respondent agreed with the statement, with 54.5% agreeing and 45.5% strongly agreeing, demonstrating unanimous support for the role of real-time data analytics in enhancing the final quality of construction projects.

Table 6. Real-time data analytics has contributed significantly to improving the overall quality of our completed projects.

		Frequency	Valid Percent	Cumulative Percent
	Agree	30	54.5	54.5
Valid	Strongly agree	25	45.5	100.0
	Total	**55**	**100.0**	

4.5. Barriers to implementing effective quality control measures in construction projects

A significant majority (80%) of participants disagreed that the cost of quality control measures is prohibitively high for the company, with only 12% agreeing.

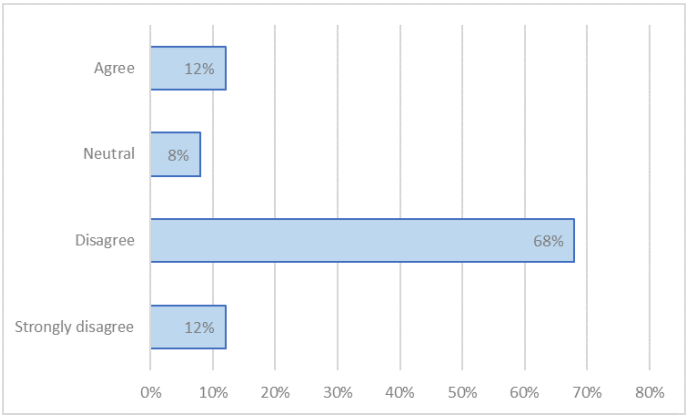

Figure 11. Cost of quality control measures

Opinions were more divided here, with 80% of participants agreeing (38% agree, 42% strongly agree) that high inspection costs deter regular checks, while a small minority (8%) disagreed. The overwhelming majority of the respondents who accepted the position were 92% on the accusation of fluctuating material costs affecting quality consistency upon the fact that 52% agreed with it and 40% strongly agreed. But on the contrary, the cost of advanced technology is seen as the main barrier as 84% of them accepted that limited access to technology does bring about 42% agreements for 42% strong.

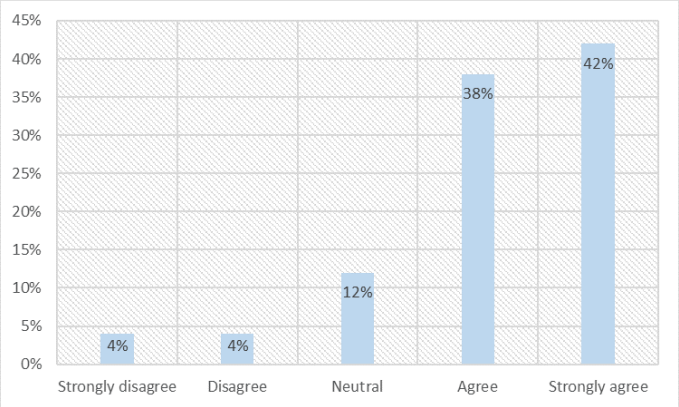

Figure 12. High costs of quality inspections

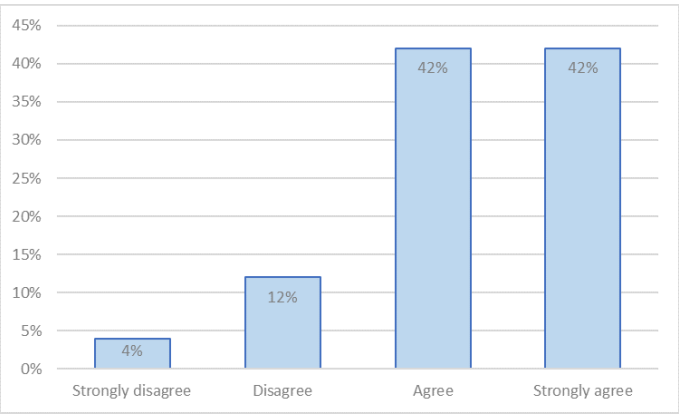

Figure 13. Limited access to advanced technology

A majority (70%) found regular updates and maintenance of quality control technology to be too expensive, with 50% agreeing and 20% strongly agreeing.

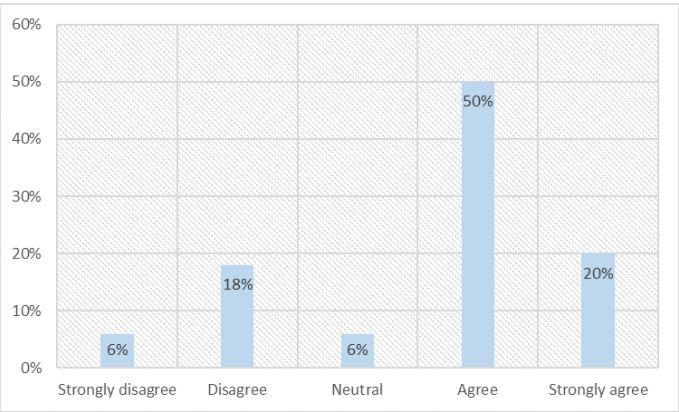

Figure 14. Cost of technology maintenance

82% of participants disagreed with the statement that a lack of training affects staff quality control abilities, while 18% were neutral.

Budget restrictions were seen as limiting for staff development in quality assurance, with 70% agreeing (58% agree, 12% strongly agree).

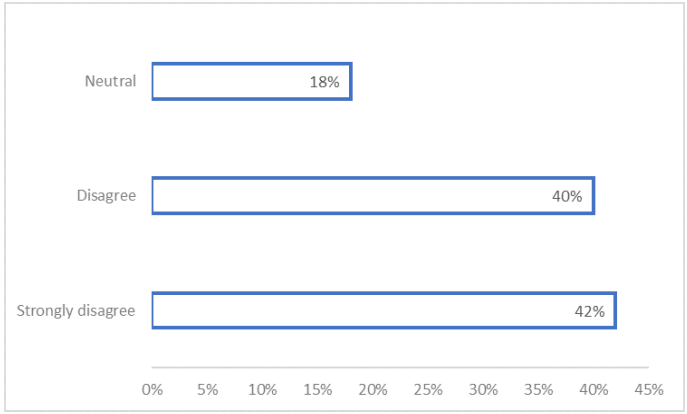

Figure 15. Impact of lack of training

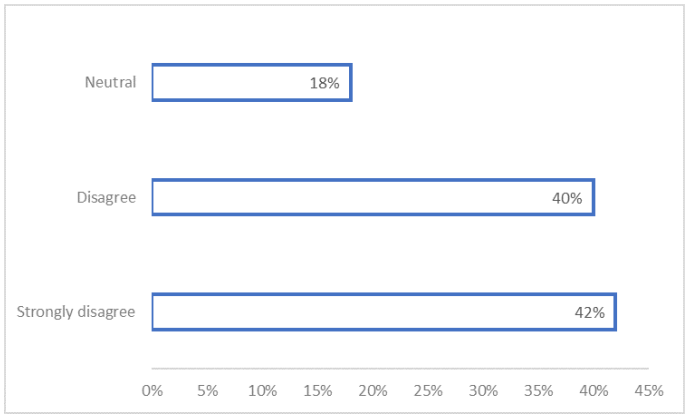

Figure 16. Budget constraints on staff development

5. CONCLUSIONS

The key to guaranteeing successful projects in construction lies within the quality control measures put in practice. Although 56.4% of respondents perceived them to work in achieving quality goals, the fact that 43.6% confronted project delays relating to quality issues calls for continuous improvement of quality control. Quality control was seen to have significantly reduced rework and increased project quality, with 81.8% and 78.2% of respondents reporting favorable outcomes respectively. With technology-enabled quality control such as BIM and quality management software, which are definitely useful and lead to reduced cycle times, minimized costs, and improved quality, a strong correlation also indicates that technology was effective for quality control. This shows how much value lies in using modern tools and technologies for quality control in construction projects.

RECOMMENDATION

There is a need for extensive training of employees in both theory and practice concerning quality standards for creating uniformity and eliminating errors. BIM and drones, as well as quality management software, are some of the latest tools that can improve efficiency and streamline inspection processes; quality audits are conducted regularly to monitor conformance and support continuous improvement. Ample resources are

a critical factor in decreasing defects and improving project performance, namely skilled personnel and top-grade materials. Resolving delays and cost overruns through technological integration, communication enhancement, and frequent quality audits must be maintained. Quality control methods are periodically updated to meet and reflect industry standards and the latest technology while ensuring quality is taken seriously and is held with accountability by Leadership Support. Well-designed feedback sessions and recognition programs for employees enhance participation in quality control processes and positively influence quality control effectiveness and employees' job satisfaction.

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