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The Extent of Adoption of Quality Management Practices in the Construction Lifecycle by Contractors of State-Owned Enterprises

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ABSTRACT

This study examined the quality management practices implemented by contractors involved in infrastructure development, specifically focusing on the various stages of the construction lifecycle such as feasibility, design, and construction, except the final phase, commissioning. A conceptual framework was developed to facilitate the implementation of quality management practices, specifically within areas of quality planning, quality control, and quality assurance. The quantitative method using a survey questionnaire has gathered the perspectives from contractors engaged in South African infrastructure projects. Data was collected from a representative subset sourced from the National Treasury Database, yielding 39 respondents. Hypothesis 1 found significant differences in practice adoption across construction stages. Hypothesis 2 revealed a strong positive correlation between quality planning and quality assurance, as well as between quality control and quality assurance, emphasizing their interconnection. The study was limited to discussing the contractors' who were employed by Eskom, a single state-owned corporation, and has restricted the emphasis on all the aspects of quality management practices in the construction industry. The results from Design Stages of Construction Projects revealed some significant differences between the opinions regarding the practice adoption across construction stages along with the distinction in quality planning predominantly in the design and construction phases

INTRODUCTION

South Africa's state-owned business contractors vary significantly in their use of quality management techniques throughout the construction lifecycle (Luthuli, 2020). Some contractors have adopted and successfully incorporated robust quality management systems into their operations, but others lag (Surty *et al.*, 2018). Various procedures and methods are included in quality management techniques, which are meant to guarantee that construction projects adhere to accepted norms and requirements and, as a result, provide safe and dependable infrastructure in the construction industry.

In construction management and project management, planning, coordinating, and overseeing the monitoring and control of a construction project is commonly referred to as project management. Before starting any construction, it is imperative to identify the quality criteria (Kerzner, 2017). Moreover, the construction management and state-owned enterprises need to adopt the design phases of the project planning process to assure the clients regarding the construction sector.

Variables, including the scope and difficulty of the construction project, the resources and expertise of the contractor, and the degree of regulatory control, influence the scope of adoption of the design process. While those handling more complex, more complicated projects frequently put a higher focus on quality assurance, contractors involved with smaller, less complex projects may not prioritize sophisticated quality control systems. Government rules and their level of enforcement also have a significant impact on how these techniques are adopted. Therefore, a variety of factors, including the industry's varied commitment to quality, influence the degree to which state-owned enterprise contractors in South Africa implement quality management systems throughout the construction lifecycle. The study conducted on the Malaysian construction sector examined the conceptualization of quality concerns and identified the presence of quality issues across the entirety of the construction process (Janipha & Ismail, 2013; Rogers *et al.*, 2015).

Construction cost management is a crucial step in the construction process and plays a vital role in the project's economic viability. The management of investment expenses directly impacts construction progress and work quality. In order to advance agricultural and rural development today, it is critical and essential to increase the effectiveness of construction cost management.

The study's scope was based on the investigation of how South African contractors connected to state-owned businesses used quality management standards throughout the construction lifecycle. With a focus on quality planning, quality control, and quality assurance, the research sought to determine the amount of adoption of quality management practices across the construction lifecycle by South African state-owned business contractors with a single state-owned entity, Eskom. Eskom Holdings SOC Limited, a state-

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owned power utility, has been in operation since its establishment in 1923. It is responsible for generating, transmitting, and distributing approximately 95% of the electricity consumed by the people of South Africa. As a government-owned entity, its primary goal is to guarantee a consistent and cost-effective electricity supply to its customers. However, Eskom currently confronts the issue of being unable to meet the growing demand for electricity in South Africa due to the increasing number of customers connecting to the national grid in recent years (Flepisi & Mlambo, 2021).

Moreover, this study revealed the hypotheses with respect to finding out any significant differences exist in the practice of adoption across the construction stages and hypotheses regarding any correlation between the quality control and quality assurance of the construction projects. These hypotheses also revealed the consistency level of achieving the results.

LITERATURE REVIEW

Quality in the area of construction management has been recognized as one of the vital factors within the success paradigm in project construction, as stated (Keenan & Rostami, 2021). Scholars such as (Fuller, 2022; Mahatlhe *et al.*, 2023; Mtotywa & Dube, 2023) extensively reviewed quality management practices. Although the researchers, in contrast, have identified and described several quality management strategies, it is worth noting that there are similarities among these practices (Montgomery, 2019). However, hypothesis 1 developed for this respective study entails identifying the significant differences in the adoption practice across the construction stages. However, some of the most prevalent practices in quality management include the commitment and support of top management, employee training, organizational structures that prioritize quality, employee involvement and engagement, emphasis on customer and supplier quality management, ongoing support, collection and analysis of information, regular enhancements to the quality system, and use of statistical quality techniques (van Assen, 2021). The quality management techniques into three primary groups: management practices, infrastructure practices, and core practices were classified by (Asif, 2019). The issuance of management practices is the responsibility of top-level management. Infrastructure practices, on the other hand, are designed to support core practices. The primary objective of the core practices is to improve the quality of the project (Agarwal *et al.*, 2013).

Organizations in the construction sector across Europe, the US, Canada, Australia, Japan, and Hong Kong have adopted total quality management (TQM) in an effort to increase quality, productivity, and customer satisfaction. Benefits include lower quality expenses, more customer recognition, happier workers, work done correctly from the start, subcontractors with appropriate quality management systems, and stronger ties with suppliers and subcontractors. Successful implementation of quality management systems (QMS) has been demonstrated by both large and small organizations. It has been demonstrated that quality management systems (QMS), ISO 9000 standards, quality control procedures, and techniques related to environmental and safety management systems are crucial in building construction projects to guarantee that the finished product is safe, satisfies quality requirements, and provides owners with what they have been offered regarding as explained by (Aichouni *et al.*, 2014).

According to Ingason (2015), a strong correlation exists between the performance of a project and its organization and the classification of quality management approaches. This correlation suggests that the outcome of a state-owned enterprise project is likely to have been significantly influenced by the quality management practices implemented. This insight was also considered during the development of hypotheses in this study, and hypotheses 2, "correlation between the quality control and quality assurance of the construction projects" was developed (Ingason, 2015),

According to estimates, the construction production value in South Africa declined by 3.3% in 2019. This decrease could be attributed to a continuous decline in working operations and activities within the construction industry since 2017. Consequently, the industry's output value, when adjusted for inflation, contracted by 3.3% in 2019. Therefore, the impact of an economic recession, along with diminished investor and consumer sentiment, has had repercussions on both public and private investments in construction projects (Abboud, 2023).

A novel concept of construction, proposed by Antunes and Gonzalez (2015), acknowledges the dynamic and occasionally contradictory nature of its definition. They argued that construction should be viewed as the tangible manifestation of a conceptual idea, achieved through the process of design, which considers functional necessities and technical specifications in the creation of a project outcome. A production model for construction was

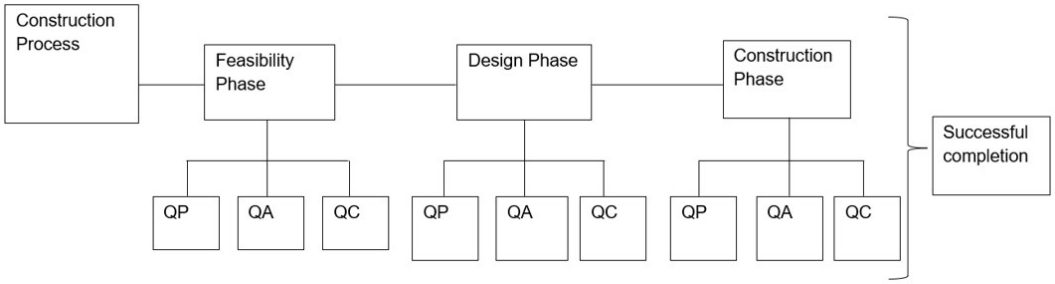

Figure 1: Quality Management Conceptual Framework for Construction

developed, and in accordance with the aims of this study, a conceptual framework was created that aligns with the production model for the construction demo, as illustrated by (Antunes and Gonzalez, 2015). The conceptual framework was used to guide the investigation into quality management practices at each stage of the construction model. This allowed for the identification of the prevailing practices within the model.

Feasibility

A feasibility study is a systematic process aimed at forecasting the potential outcomes of an investigation, analysis, or assessment of a proposed program, as well as the potential benefits that may arise from it. Moreover, the feasibility study provides a thorough examination and assessment of production plans or commercial opportunities, along with the prerequisites for initiating the project (Mukherjee and Roy, 2017). The authors expanded upon the notion that the appropriate protocol for investigating and evaluating the proposed project primarily involves the identification of potential issues, specifications, anticipated performance, cost analysis of each subsystem, and the selection of the optimal and most effective techniques.

Designing Process

The process of designing facilities entails the creation of comprehensive plans and specifications that outline the details of the intended structures. Building and construction planning comprises the identification and allocation of necessary and significant activities and resources required to transform the envisioned facilities into tangible entities Project Management (n.d). Additional evidence (Ilveskoski and Niittymäki, 2015) provided that the design process consists of distinct phases, such as programming and feasibility, schematic design, design and development, and contract documents. However, the design process is not a singular occurrence but rather a cyclical and multifaceted progression.

Moreover, studies like those (El-Sayegh ans Mansour, 2015) confirm that the construction industry possesses a higher level of risk due to certain features of construction projects. The construction projects are essentially characterized by a variety of uniqueness, along with complexity in their nature, involvement from various stakeholders, substantial capital requirements, changing conditions, extended production periods, and susceptibility to external factors and weather conditions (Siraj and Fayek, 2019). Additionally, (Hasan *et al.*, 2018) quantified design flaws and found that these errors accounted for total quality failures. This study provides a concise overview regarding design challenges related to quality, which have been recognized as a substantial factor contributing to the high incidence of quality failure.

The presence of inadequacy sometimes results in the occurrence of errors. The flaws were acknowledged to have a disruptive impact, increasing information requests, design modifications, coordination challenges, rework, and scheduling difficulties. The quality of implementation can be enhanced when there are a variety of perspectives on the design, as reported by (Othman *et al.*, 2020). According to Martin and Benson (2021), the authors proposed that contractors and subcontractors heavily rely on the given information, which is of significant concern. They then emphasize the importance of good design documentation quality.

Construction Management

Construction management involves the systematic organization and coordination of several activities, including planning, monitoring, and control, to effectively execute a construction project. The project management approach is specifically tailored for the construction sector, as indicated by its name. Moreover, quality control plays a crucial role in the construction process. When implemented well during this stage, there is a strong likelihood of improving the overall quality of the project Dutta *et al.* (2021) asserted that quality control is a crucial process aimed at ensuring the fulfilment of product or project requirements. The process is employed to assess the quality attributes of a project in relation to established benchmarks and to evaluate the disparities between the actual and anticipated outcomes. Quality control, as defined by the (Guide, 1996), refers to a systematic procedure involving the observation and assessment of project outcomes and their effects to determine their compliance with predetermined quality criteria. In addition, it involves the identification and resolution of underlying factors contributing to any subpar outcomes (Guide, 1996).

METHODOLOGY

Research Design: Quantitative Approach

Research design plans are comprehensive outlines that detail the methodology for empirical data collection in research. They serve as a strategic framework, as described by Yin (2009), to guide the progression from the current state to the desired outcome, addressing specific research inquiries or testing hypotheses. In a prior definition, Yin (2002) characterized research design as the systematic arrangement and organization used to approach research questions. The selected research design for this study was a quantitative approach involving a systematic collection of and analysis of numerical data to test hypotheses and answer specific research questions designed for this study. The quantitative approach was selected for several reasons, and it is integral to the study for the following key reasons:

Measuring Quantifiable Variables

This study aims to assess the extent of the adoption of quality management practices in the construction lifecycle by contractors. Such quality management practices can be quantified in terms of the degree of implementation, adherence to standards, and perceived importance. A quantitative approach is ideal for measuring these variables precisely.

Objectivity and Replicability

Quantitative research is known for its objectivity and replicability (Mohajan, 2020). It uses research instruments based on research standards, such as Likert scales in this respective study, to collect data. This aspect ensures that the data collected possess consistency and can be easily replicated by other researchers to enhance the credibility of the study.

Statistical Analysis

A quantitative research approach allows the application of statistical techniques to analyse the data (Mertler *et al.*, 2021). In the following study, the primary goal is to examine the relationships between variables, such as the perceived importance of quality management practices and the extent of their implementation. Statistical analysis tools such as Spearman's rank correlation coefficient, also called "Spearman Rho," can provide some valuable insights into these relationships. Additionally, the quantitative method is commonly described as "largely adopting the natural science experiment as a model for scientific inquiry". This approach is characterized by using quantitative measurement to study phenomena and the systematic control of theoretical variables that influence these phenomena.

Data Collection

A survey questionnaire was designed and presented to contractors working on Eskom projects. The poll used a Likert scale to assess how important planning, control, and assurance quality management practices were anticipated to be. According to Bell (2005), this scale is helpful for assessing attitudes and emotions on the presumption that each scale item carries equal attitudinal weight. This scale's use offered insightful information on the participants' opinions about QMPs.

Sampling

According to Asenahabi (2019), "the unit of analysis is defined as the individual, group, or entity that is the focus of the research inquiry". A sampling frame was determined from the sampling unit. The sample frame refers to a comprehensive roster of individuals belonging to the target population who possess the potential to provide valuable contributions to the research project. The sampling frame used in this study was obtained from the Central Supplier Database (CSD), which is a component of the National Treasury Database. A comprehensive investigation was conducted to identify potential participants for the study by searching for suppliers and their corresponding commodities.

A total of seventy (70) surveys were distributed using online survey software, including Question Pro and Google Forms. Forty (40) viable samples were utilized, with one questionnaire response excluded due to a substantial amount of missing data. The participants proposed the idea of obtaining referrals from individuals within the study who knew the topics at hand. The technique is commonly referred to as the snowball sampling approach. Nonetheless, the study failed to determine the influence of the snowball strategy, and it remains indeterminate whether the participants were the initial respondents from the CSD or the referred individuals.

Data Analysis

The results of the survey questionnaire were subjected to both descriptive and inferential analyses using the SPSS-26 version tool. By employing this approach, the research has successfully examined the degree to which quality management practice is implemented throughout a construction project. Because of the inadequate response rate obtained for the questionnaires, the use of parametric statistics, such as Pearson correlation, was not viable because of the failure to satisfy prerequisites such as adherence to a statistical distribution. Given the ordinal character of the answer scale used in the study, it was necessary to employ non-parametric statistical techniques, such as Spearman's rank correlation coefficient (Spearman Rho). The use of descriptive statistics facilitated the effective presentation of the data, thus aiding in its understanding. The reliability of the scale was assessed using Cronbach's alpha.

RESULTS AND DISCUSSION

Table 1: Importance in the feasibility stages of the project

Construct	Category	N	Percentage	Mean
Quality Planning	Most important	24	61.5	1.56
	Moderately important	4	10.3	
	Least important	8	20.5	
	Missing	3	7.7	
Quality Control	Most important	5	12.8	2.11
	Moderately important	21	53.8	
	Least important	9	23.1	
	Missing	4	10.3	
Quality Assurance	Most important	7	17.9	2.33
	Moderately important	10	25.6	

	Least important	19	48.7	
	Missing	3	7.7	

Importance in the Feasibility Stages of Construction Projects

Quality Planning

The results indicate that 24 (61.5%) of the participants ranked quality planning as most important, 4 (10.3%) as moderately important, and 8 (20.5%) as least important in the feasibility stages of the project. Three participants did not record a ranking. The mean value was M = 1.56 as shown in the Table 1.

Quality Control

The results indicate that 5 (12.8%) of the participants ranked quality control as most important, 21 (53.8%) as moderately important, and 9 (23.1%) as least important in the feasibility stages of the project. Four participants did not record a ranking. The mean value was M = 2.11 as demonstrated in Table 1.

Quality Assurance

The results indicate that 7 (17.9%) of the participants ranked quality assurance as the most important, 10 (26.5%) as moderately important, and 19 (48.7%) as least important in the feasibility stages of the project. Three participants did not record a ranking. The mean value was M = 2.33.

Table 2: Importance in the design stages of the project

Construct	Category	NA	Percentage	Mean
Quality Planning	Most important	24	61.5	1.64
	Moderately important	5	12.8	
	Least important	10	25.6	
Quality Control	Most important	6	15.4	2.19
	Moderately important	18	46.2	
	Least important	13	33.3	
	Missing	2	5.1	
Quality Assurance	Most important	9	23.1	2.14
	Moderately important	14	35.9	
	Least important	14	5.1	
	Missing	2		

Importance in Design Stages of Construction Projects

Quality Planning

The results indicate that 24 (61.5%) of the participants ranked quality planning as the most important, 5 (12.8%) as moderately important, and 10 (25.6%) as least important in the design stages of the project. The mean value was M = 1.64 as described in Table 2.

Quality Control

The results indicate that 6 (15.4%) of the participants ranked quality control as the most important, 18 (46.2%) as moderately important, and 13 (33.3%) as least important in the design stages of the project. Two participants did not record a ranking. The mean value was M = 2.19 as shown in Table 2.

Quality Assurance

The results indicate that 9 (23.1%) of the participants ranked quality assurance as the most important, 14 (35.9%) as moderately important, and 14 (35.9%) as least important in the design stages of the project. Two participants did not record a ranking. The mean value was M = 2.14.

Table 3: Importance in the construction of the project

Construct	Category	NA	Percentage	Mean
Quality Planning	Most important	14	35.90	1.95
	Moderately important	12	30.77	
	Least important	12	30.77	
	Missing	1	2.56	
Quality Control	Most important	10	25.64	2.06
	Moderately important	14	35.90	
	Least important	12	30.77	

	Missing	3	30.77	
Quality Assurance	Most important	12	30.77	2
	Moderately important	12		
	Least important	12		
	Missing	3		

Importance in the Construction Stage of the Construction Projects

Quality Planning

The results indicate that 14 (35.9%) of the participants ranked quality planning as most important, 12 (30.8%) as moderately important, and 12 (30.8%) as least important in the construction of the project. One participant did not record a ranking. The mean value was M = 1.95.

Quality Control

The results indicate that 10 (25.6%) of the participants ranked quality control as the most important, 14 (35.9%) as moderately important, and 12 (30.8%) as least important in the construction of the project. Three participants did not record a ranking. The mean value was M = 2.06.

Quality Assurance

The results indicate that 12 (30.8%) of the participants ranked quality assurance as most important, 12 (30.8%) as moderately important, and 12 (30.8%) as least important in the construction of the project. Three participants did not record a ranking. The mean value was M = 2.00.

Quality Planning, Quality Control, and Quality Assurance Constructs

Table 4: Correlation analysis for the main constructs

Construct	Statistic	Quality Planning	Quality Control	Quality Assurance
Quality Planning	Correlation Coefficient	1	0.398	0.564
	p-value		0.012	0.000
	N	39	39	39
Quality Control	Correlation Coefficient	0.398	1	0.736
	p-value	0.012		0.000
	N	39	39	39
Quality Assurance	Correlation Coefficient	0.564	0.736	1
	p-value	0.000	0.000	
		39	39	39

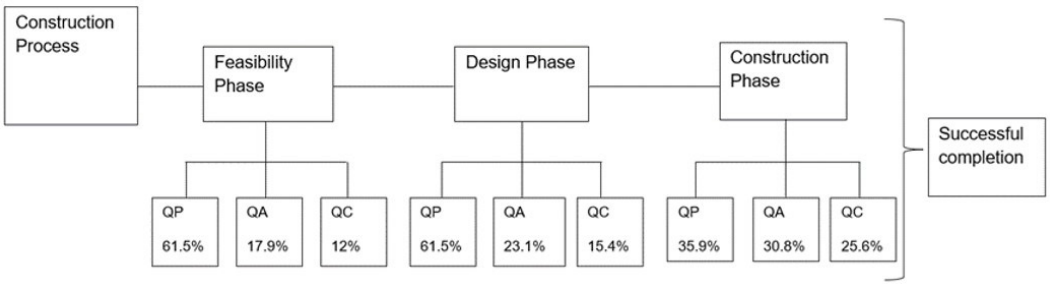

Figure 2: Quality management conceptual framework for construction after successful completion with percentages of implementation

DISCUSSION

Regarding the significance of implementing quality management practices throughout the feasibility stages of a construction project, a more significant number of respondents preferred prioritizing quality planning as the most crucial practice when starting a project. Quality planning entails the process of identifying quality standards (Prashar, 2023). This concept aligns with the customary approach of arranging and engaging in a manner that fulfils the purposes of identifying and establishing the specific criteria pertinent to the project. Before starting the project, the contractor must ensure that they can fulfil the prescribed standards and requirements. The absence of adherence to the pursuit of quality planning may result in negative consequences during project execution (Siraj and Fayek, 2019).

During the phases of the design process, the practice of quality planning was recognized as the foremost

aspect of quality management. According to the existing literature, design can be defined as the systematic process of developing a comprehensive description of a new facility, typically conveyed through detailed plans and specifications (Babalola *et al.*, 2019). Such demonstration of the concept aligns with the established criteria of quality planning. Before starting the design conversion process, the designer or client first ascertains and delineates the specifications and plans (Wuni *et al.*, 2022). However, the results from the Design Stages of Construction Projects revealed that there are significant differences between the opinions regarding the practice adoption across construction stages and also the distinction in quality planning predominantly in the design and construction phases. Thus, this demonstrated H1.

An acknowledgement was made that the designer functions as a customer of the owner. The primary responsibility of the contractor is to acknowledge and execute the design plans provided by the client. The primary concern faced by the contractor lies in determining the most effective approach to incorporate quality planning measures while using the designer's plan and specifications as the basis for executing the construction process (Arditi & Gunaydin, 1997). Given the ambiguous nature of the roles played by the client, designer, and contractor, the contractor is compelled to undertake the responsibility of implementing comprehensive quality planning measures that surpass the specifications provided by the customer (Harris *et al.*, 2021).

Quality planning is of utmost importance during the construction process. It is consistent with the established concept of construction. The process of planning, coordinating, and overseeing the monitoring and control of a construction project is commonly referred to as project management. Before starting any construction, it is imperative to identify the quality criteria (Kerzner, 2017). The present study suggests that the implementation of quality planning is crucial at all stages of the project lifecycle. The rationale for quality planning is its focus on using all available information at the onset of a project to determine strategies for adhering to implementation standards and preventing defects. According to the findings of (Erdogan *et al.*, 2019), a project contractor and client at the same time play a definite role in project success by providing requirements and specifications that must be adhered to (Erdogan *et al.*, 2019). Satisfying the requirements outlined by the project is merely one interpretation of accomplishment. It is common for clients to have expectations that are particularly challenging to capture within a written specification.

The correlation between quality planning and quality control exhibited a moderate level of strength, whereas the association between quality planning and quality assurance showed a great level of strength. The process of quality assurance involves the evaluation of the performance of a project. Thus, after establishing specific quality standards based on the project requirement, it is essential to assess the extent to which these standards, plans or specifications have been executed by analysing their performance. It is equally essential for construction owners and contractors at state-owned enterprises to be well-informed about the concept of quality assurance so that they can advocate for the adoption of this approach to safeguard their investments and minimize construction costs (Salvi & Kerkar, 2020).

Moreover, the results revealed and suggested that the association between quality control in construction projects and quality assurance was shown to be quite strong and positively correlated; thus, H2 was justified. Therefore, the potential reason for this phenomenon may stem from the frequent and interchangeable usage of these phrases by individuals. Within the construction sector, clients engage in the process of evaluating the work performed by contractors through inspections (Abbas, 2020). However, these inspections primarily serve as a means of assuring and reviewing the completed work, encompassing quality control measures. The contractor conducts the inspection and afterwards demands the presence of the client to provide assurance.

CONCLUSION

An investigation of the primary quality management practices employed in the construction lifecycle of infrastructural projects inside state-owned enterprises revealed that quality planning emerged as a widely adopted quality practice and is significantly different from project to project, as revealed in H1. A greater proportion of respondents favored ranking quality planning as the most important practice when beginning a project when discussing the importance of applying quality management practices throughout the feasibility stages of a building project. Furthermore, the data revealed a positive correlation between the construction projects. Thus H2 revealed. The resolution of the issue of ownership of the design phase is crucial within the construction business because it serves to mitigate the occurrence of design flaws that the contractor may introduce during the construction process.

LIMITATIONS

The primary focus of the research was on contractors whom Eskom, a single state-owned corporation, employed. In addition to the possibility that various state-owned companies could employ different procedures and standards, this restricted emphasis may not adequately represent all aspects of quality management practices in the construction sector. In order to provide a more thorough study, future research should take a broader spectrum of state-owned firms into account. The results of the study have been restricted to a particular region or nation. Between areas and nations, there can be significant differences in construction methods, rules, and customs. Another restriction is the possibility of a variable that causes confusion that is not mentioned in the data that is provided. The study's internal validity could be harmed if relevant confounding factors have not been determined

and eliminated. In order to ensure the correctness of the findings, future studies should target the identification and address these issues and to improve the dependability of the results.

RECOMMENDATIONS

This study provides possible recommendations for future research by comparing the quality management techniques used by various state-owned firms in their construction projects. Therefore, future studies will give a more comprehensive understanding of the variations and connections between quality planning and other quality management techniques. Moreover, researchers can evaluate the efficiency of quality management techniques during the entire construction lifecycle by considering longitudinal studies. This strategy would give information on how these techniques' long-term effects on project results by utilizing both quantitative and qualitative data collection techniques. This method may provide a more thorough knowledge of the variables affecting quality control in construction projects. The efficacy of the suggested framework, which assesses the significance of quality management practices throughout the construction lifecycle, should be empirically examined to validate its effectiveness in ensuring successful project completion.

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