



Statistical Quality Control for Enhancing Construction Project Performance: Statistician and Quantity Surveyor Perspective

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Abstract: Statistical Quality Control (SQC) provides a powerful framework for improving project outcomes by integrating statistical methodologies with construction cost management principles. This paper explores how SQC techniques, such as control charts, process capability analysis, and acceptance sampling, can be applied in construction projects from the dual perspectives of a statistician and a quantity surveyor. From a statistician's standpoint, advanced statistical tools provide insights into process variability, cost optimization, and project timeline management. Meanwhile, the quantity surveyor contributes expertise in cost control, budgeting, and resource allocation. This interdisciplinary approach leverages data-driven decision-making to enhance project performance in terms of quality, cost efficiency, and timely delivery. The study utilizes data from 50 construction projects across Nigeria, employing statistical methods like hypothesis testing, regression analysis, and variance analysis, alongside quantity surveying techniques for budgeting and financial forecasting. The results reveal that integrating SQC with quantity surveying significantly improves project performance by reducing variability in costs and timelines. This collaborative approach demonstrates the complementary roles of statisticians and quantity surveyors in applying SQC techniques to enhance overall construction efficiency. The findings highlight the need for a stronger partnership between statistical and construction management professionals to drive optimal project outcomes. Recommendations for practical application and future research are discussed, with emphasis on bridging the gap between statistical analysis and construction cost management.

Keywords: Statistical Quality Control, Construction Project Performance, Construction Industry, Quality Control Techniques and Project Management

1.0 INTRODUCTION

The integration of Statistical Quality Control (SQC) techniques into the construction industry has the potential to greatly improve project outcomes. While SQC has been widely applied in manufacturing and other industries, its use in construction remains limited. From the dual perspectives of a statistician and a quantity surveyor, the application of SQC techniques can provide valuable insights into both process control and financial management, key aspects of successful project delivery (Montgomery, 2020; Ahuja *et al.*, 2018).

For the statistician, SQC tools such as control charts and process capability analysis provide a structured way to monitor project performance, identify variability, and optimize processes. These methods help quantify the impact of different factors on project outcomes like cost and schedule adherence (Joseph & George, 2019). On the other hand, quantity surveyors play a crucial role in managing project costs, ensuring that the financial aspects of the project align with predefined budgets and forecasts (Ofori,

2020). Together, these two disciplines form a powerful partnership, blending statistical analysis with financial expertise to enhance construction project efficiency.

The aim of this paper is to explore the integration of SQC techniques with quantity surveying practices to improve construction project performance. By combining the statistical rigor of SQC with the cost management expertise of quantity surveyors, this paper seeks to highlight how this interdisciplinary approach can optimize construction outcomes in terms of cost, quality, and time. The objectives are;

1. To examine the role of Statistical Quality Control (SQC) techniques in enhancing construction project performance.
2. To explore the integration of SQC techniques with quantity surveying practices in construction projects.
3. To assess how the interdisciplinary collaboration between statisticians and quantity surveyors can optimize construction outcomes in terms of cost, quality, and time.



4. To evaluate the effectiveness of applying SQC techniques in improving construction process control and quality management.

1.1 Introduction to Statistical Quality Control (SOC)

Statistical Quality Control (SQC) refers to the application of statistical methods to monitor and control a process, ensuring that it operates at its full potential. Originating from industrial production, these techniques are now widely applied in various sectors, including construction. In construction projects, the need for efficiency, cost management, and timely delivery makes SQC essential to maintaining quality and enhancing performance (Montgomery, 2019). Effective use of SQC can help detect early deviations in construction processes, allowing for timely corrections, thus avoiding costly reworks (Oakland, 2014).

1.2 Construction Project Performance and Quality

Construction project performance is typically assessed through key metrics such as cost, time, and quality (Durdyev *et al.*, 2017). Quality management is an essential component of project performance, ensuring that construction processes meet specified standards and client expectations. Poor quality in construction projects can lead to delays, increased costs, and potential safety hazards. Traditional quality management in construction is often reactive, identifying defects after they have occurred. However, the application of SQC allows for proactive quality control through continuous monitoring, thus improving overall project performance (Tague, 2005).

1.3 Application of SQC in Construction

In the construction industry, SQC techniques such as control charts, acceptance sampling, and process capability analysis are used to monitor construction processes. Control charts, for instance, can track the stability of construction materials like concrete and steel, ensuring consistency in quality (Juran & Godfrey, 1999). Acceptance sampling is another technique used to determine if a batch of materials or work meets predefined quality standards without inspecting the entire batch, thus saving time and resources (Montgomery, 2019). Additionally, Process Capability Indexes (PCI) measure the ability of a construction process to produce outputs within the specification limits, identifying whether processes need improvement (Oakland, 2014).

1.4 Challenges in Implementing SQC in Construction

Despite the potential benefits, the adoption of SQC in construction faces several challenges. A primary challenge is the variability inherent in construction projects due to external factors like weather conditions, labor skills, and site-specific conditions (Abdel-Razek *et al.*, 2007). Furthermore, construction projects are often characterized by one-off, unique designs, which can complicate the application of standard SQC techniques that are more commonly used in repetitive manufacturing processes. Another challenge is the resistance to adopting statistical techniques in an industry that has historically relied on subjective assessments of quality (Low & Yeo, 2016).

1.5 Collaborative Role of Statisticians and Quantity Surveyors

The collaboration between statisticians and quantity surveyors in construction projects can significantly enhance the implementation of SQC techniques. Statisticians provide expertise in data analysis and process control, ensuring that the statistical methods are appropriately applied to monitor and improve construction processes (Montgomery, 2019). Quantity surveyors, on the other hand, bring insights into cost management and procurement, ensuring that quality improvements align with project budgets and timelines (Ashworth, Hogg, & Higgs, 2013). This interdisciplinary approach can lead to more efficient project execution, improved cost control, and higher quality standards.

1.6 Case Studies on SQC in Construction

Several case studies demonstrate the effectiveness of SQC in enhancing construction project performance. For example, a study by Love *et al.* (2018) showed that the application of control charts in monitoring concrete strength reduced the incidence of defects by 20% in a large infrastructure project. Similarly, the use of acceptance sampling for materials inspection in a commercial building project led to a 15% reduction in time spent on quality inspections, while maintaining high-quality standards (Montgomery, 2019). These case studies highlight the practical benefits of SQC in improving construction efficiency and quality.

2.0 METHODOLOGY

2.1 Study Design

The research employs a mixed-methods approach, combining quantitative statistical analysis with cost estimation techniques from quantity surveying. Data from 50 construction projects across Nigeria were collected and



analyzed. Key SQC techniques, such as control charts and process capability analysis, were applied to monitor performance indicators like cost variability and timeline adherence. The study also integrated cost management principles from quantity surveying, focusing on budgeting, financial forecasting, and resource allocation.

2.2 Statistical Tools

Control charts (X-bar, R-chart), process capability indices (Cp, Cpk), and regression models were used to analyze construction process data and predict outcomes.

2.3 Quantity Surveying Techniques

Cost estimation, financial forecasting, and variance analysis were applied to monitor and manage project budgets.

2.4 Data Collection

2.4.1 Quantitative Data

Data on cost performance, project timelines, and quality control were gathered from construction projects. SQC tools were applied to assess variability in these metrics.

2.4.2 Quantity Surveying Data

Financial data on project budgets, costs, and expenditures were collected and analyzed using standard quantity surveying techniques

2.4.3 Quantity Surveying Data

Statistical analysis, including ANOVA and regression modeling, was employed to assess the relationship between SQC implementation and project outcomes. Simultaneously, quantity surveying methods were used to estimate project costs, and variance analysis was conducted to identify discrepancies between estimated and actual costs.

3.0 RESULTS

The results demonstrate that integrating SQC techniques with quantity surveying practices leads to significant improvements in construction project performance. Projects that adopted SQC methods, such as control charts and process capability analysis, showed lower variability in cost and time performance compared to those that did not.

From a quantity surveyor's perspective, cost estimation and financial forecasting were found to be more accurate when combined with SQC tools, as the statistical analysis helped identify key sources of variability affecting project budgets. The ANOVA results indicated statistically significant differences ($p < 0.05$) in project performance based on the adoption of SQC tools.

Project Type	SQC + QS Adoption Rate	Average Cost Variability (SD)	Time Reduction (%)	Process Capability (Cp)
Residential	70%	0.12	15%	1.40
Commercial	75%	0.09	20%	1.50
Infrastructure	60%	0.18	12%	1.30

Regression models showed that projects employing both SQC and quantity surveying techniques experienced up to 20% cost savings and a 15% reduction in project completion times.

This research highlights the powerful synergy between SQC techniques and quantity surveying in enhancing construction project performance. Statisticians contribute to improving project quality and efficiency through the use of control charts, process capability analysis, and other statistical tools (Montgomery, 2020). Meanwhile, quantity surveyors provide essential expertise in cost estimation, financial planning, and resource management, ensuring that projects stay within budget while delivering high-quality results (Ofori, 2020).

The integration of these two disciplines significantly reduces variability in project outcomes, leading to more predictable costs and timelines. The findings are consistent with other studies that emphasize the value of combining statistical tools with construction management techniques (Love, 2017; Wong, 2020). Additionally, the results underscore the importance of continuous monitoring and process control, especially in complex construction environments where cost overruns and delays are common.

Future research should focus on developing user-friendly tools that integrate both statistical and financial analysis, enabling construction professionals to apply these techniques more easily in practice. Training programs that foster collaboration between statisticians and quantity surveyors will also be essential for maximizing the benefits of this interdisciplinary approach.

4.0 CONCLUSION

This paper demonstrated that combining Statistical Quality Control (SQC) techniques with Quantity Surveying practices can greatly enhance construction project performance. From the statistician's perspective, SQC provides a data-driven framework for monitoring and optimizing project outcomes, while the quantity surveyor ensures financial discipline and cost efficiency. Together, these two disciplines offer a comprehensive approach to managing variability, improving quality, and controlling project costs.



The study's results showed that projects using both SQC and Quantity Surveying practices experienced substantial improvements in cost control, project timelines, and quality outcomes. As the construction industry continues to face challenges related to variability and inefficiency, this interdisciplinary approach provides a valuable solution for delivering better project outcomes. Further research should explore the development of integrated tools and methodologies to streamline the application of these techniques across diverse construction projects.

The study offers a novel interdisciplinary approach by integrating Statistical Quality Control (SQC) techniques with Quantity Surveying (QS) practices. This collaboration demonstrates the complementary roles of statisticians and quantity surveyors in optimizing construction project outcomes. The research highlights the synergy between statistical process control and financial management in reducing cost variability and enhancing project timelines.

The research provides practical insights into how SQC tools such as control charts, process capability analysis, and acceptance sampling can be effectively applied to construction projects. This is significant because the use of SQC in construction, unlike manufacturing, is not widespread. The study helps bridge this gap by demonstrating the value of statistical methods in improving construction quality and cost efficiency.

The work suggests areas for future development, particularly the creation of user-friendly tools and methodologies that combine statistical and financial analysis for more seamless application in construction. This opens the door for further exploration into technology-driven solutions, such as the use of BIM and IoT, to enhance real-time quality control.

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