

An Evaluation of Time and Cost Performance of Construction Projects in Implementing Total Quality Management Principles

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DOI: 10.36108/cbpm/2026.0122

Abstract

Purpose: The study evaluate cost and time overruns in construction projects carried out in Imo State, Nigeria, using Total Quality Management (TQM) principles.

Design: Structured questionnaires were used; the sample comprised 106 respondents, and data from 42 construction projects were included. The analysis used percentile analysis and a paired-samples t-test, which were presented in tables.

Findings: The project duration increased significantly, from an estimated average of 33.83 weeks to the actual completion time of 38.83 weeks ($t = 2.305$, $p = 0.026$). The cost analysis shows no statistically significant difference between estimated and actual cost ($t = -0.516$, $p = 0.608$), indicating that cost performance on TQM-associated projects was stable and broadly within budget. The time analysis reveals a statistically significant mean overrun of 5 weeks (12.3%) ($t = 2.305$, $p = 0.026$). The 12.31% overrun is substantially lower than the 70-188% overruns documented in comparable Nigerian studies.

Research Limitation and Implications: It is limited to construction projects in imo state.

Practical Implications: Regular use of TQM enhances overall project performance and reduces discrepancies between planned and actual performance.

Keywords: Cost Overrun, Iron Triangle, Time Overrun, Time Performance, Total Quality Management.

1. Introduction

One of the most significant factors in competitiveness, customer satisfaction, and profitability is quality, which involves doing things right to achieve excellence and reliability (Alzoubi et al., 2022). It involves consistency, the ability to produce defect-free products or services repeatedly, and fitness for purpose, the guarantee that a product or service fulfils its intended purpose (Gomaa, 2025). Barry & Campbell (2024) define quality as the level of excellence in terms of reliability, maintainability, and performance. In the construction industry, management plays a vital role in ensuring that resources, including labour, materials, machinery, and finance, are used effectively to produce high-quality results (Olurin et al, 2023). According to Shead (2010), management is the process of accomplishing tasks efficiently through coordinated effort, and Adusa-Poku (2014) defined it as the application of knowledge and experience to achieve practical outcomes.

Total Quality Management (TQM) combines the two key concepts of quality and management into a pervasive system of continuous improvement and organisational excellence (Schiavone et al., 2023). According to Lepisto et al. (2024), TQM is a

comprehensive process that focuses on customer satisfaction, teamwork, top management commitment, and continuous improvement. Similarly, Deshmukh (2023) viewed TQM as a proactive philosophy that avoids defects during manufacturing rather than fixing them afterwards. Fundamentally, TQM is not a short-term project but a long-term cultural shift, and everyone in an organisation plays a role in improving quality (Putra & Arifin, 2022). TQM in the construction industry focuses on quality planning, quality control, quality assurance, and continuous improvement, thereby contributing to a culture of accountability, efficiency, and client satisfaction. The research problem centres on frequent cost and time overruns in construction projects despite efforts to enhance quality through TQM. Although TQM is a well-established concept in manufacturing and service industries, its application in the construction industry is low and uneven (Egwunatum et al., 2024). As Deshmukh (2023) notes, the implementation of TQM in the construction sector can minimise rework and cost waste and enhance efficiency, yet its potential has not been fully utilised in Nigeria. The industry is still grappling with ineffective communication, undertraining, obsolete tools, and management's lack of commitment, major obstacles to effective TQM implementation (Dilawo & Salimi, 2019).

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This research assessed the time and cost performance of construction projects in Imo State, Nigeria, that apply Total Quality Management (TQM) principles, to determine the extent of time and cost overruns in projects implemented using TQM-grounded practices compared with those implemented using conventional management models. The study compares estimated and actual project performance data from a project that uses TQM principles and performance outcomes and includes a non-comparison group.

2. Literature Review

2.1 Total Quality Management (TQM)

Many researchers have defined Total Quality Management (TQM). According to Deshmukh *et al.* (2023), TQM is defined as the continuous improvement of individuals, groups, departments, and organisational processes aimed at satisfying customer requirements first time and every time. Permana (2021) defines it as the condition of an organisation in which all activities and functions are designed and executed in a way that satisfies all external customer requirements, with less internal tuning and lower costs, and a better workplace climate. According to Helmond (2023), TQM refers to an organisation's long-term commitment to continuously improving quality through the active involvement of all members at all levels to meet and exceed customer expectations. The Total Quality Management (TQM) concept originated in the manufacturing Industry, leading some to believe it would not be applicable to other industries (Deshmukh *et al.*, 2023). Irrespective of the fact that construction is unlike the manufacturing sector in terms of uniqueness in production. Alawag *et al.* (2024) affirmed that the merits and applicability of TQM in the Construction Industry help ensure that organisations do the right things correctly in the endless war on waste. TQM thus emphasises continuous improvement in product and service quality. According to Alam *et al.* (2024), TQM is a management philosophy and set of practices that strive to use an organisation's human and material resources as efficiently as possible to achieve its goals. It is a collection of guiding principles that form the backbone of an organisation in a state of constant improvement. TQM entails applying quality management principles and ideas across all dimensions of business operations (Abbas & Kumari, 2023). Roland (2010) further identified TQM as management practices across the firm geared towards ensuring that the organisation continuously meets or exceeds customer requirements, and highly emphasised process measurement and controls as a means of continuous improvement. Alawag *et al.* (2024) opined that TQM in the construction business refers to the ability of products and procedures to meet the set requirements and specifications.

2.2 Theoretical Framework: The Iron Triangle of Project Performance

This study is grounded in the Iron Triangle framework, also known as the Triple Constraint Model, which holds that every construction project operates within three interdependent performance constraints: cost, time, and quality (Atkinson, 1999; Kerzner, 2025). A change in one constraint typically affects the others unless scope or resources are adjusted (Fayomi *et al.*, 2023). Total Quality Management is a quality intervention, and the Iron Triangle predicts that quality investment should produce corresponding improvements in cost and time performance by reducing rework and strengthening process discipline (Alawag *et al.*, 2024). This study empirically tests that prediction. The finding that cost performance was statistically stable, while time performance showed a confirmed overrun, suggests that partial alignment with TQM protected the cost constraint but had insufficient reach over the time constraint at this stage of implementation.

3. Research Methodology

A quantitative survey was used to determine the performance of time and cost in construction projects, as applied to Total Quality Management (TQM) principles, in Imo State, Nigeria (Vivek & Rao, 2022). The survey methodology was chosen because it is effective at obtaining structured results from a large sample of construction professionals and, consequently, provides reliable and objective analysis (Dubey & Kothari, 2022). The target population comprises 172 construction firms registered with the Ministry of Works in Imo State. The minimum sample size was calculated using Yamane's (1967) formula: $n = N / (1 + N(e)^2) = 172 / (1 + 172 \times 0.01) \approx 63$ firms. A total of 63 accessible firms were identified using convenience purposive sampling. Within each firm, 2 to 4 professionals were selected as respondents. Of 159 distributed questionnaires, 106 were completed and returned, yielding a response rate of 66.7%. A project was classified as TQM-implementing if the respondent confirmed the application of at least five of the ten TQM principles assessed in the instrument, including procurement quality control, quality monitoring systems, and site management responsibility. The study conformed to a positivist paradigm, focusing on quantifiable facts to determine the relationship between TQM implementation and project performance in terms of time and cost efficiency. A structured questionnaire was used as a data collection instrument (Vincent *et al.*, 2021), a similar approach in their studies. To analyse the data, percentiles and paired-sample t-tests were used to assess the statistical significance of differences in time and cost between estimated and actual project performance. The statistical analysis was performed using SPSS, which provided empirical data on the effectiveness of TQM-based delivery of construction projects (Alawag *et al.*, 2023).

4. Discussion Of Findings

4.1 Characteristics of Questionnaire Respondents

Analysis of the respondents shows that the most represented professionals are Engineers and Quantity Surveyors, with about 38 (36%) and 29 (27%) responses, respectively. This shows that the most dominant construction professionals employed by construction firms are engineers and quantity surveyors, who account for more than 50% of respondents. This is followed by Architects and Builders, with response rates of about 20 (19%) and 19 (18%), respectively. However, most of the respondents sampled possess HND 41 (39%) and B.Sc / B.Tech 37 (35%), while about 15 (14%) and 13 (12%) have PGD and M.Sc / M.Tech degrees, respectively. In terms of years of experience, this research shows that only about 30 (28%) have fewer than 5 years, while a larger share exhibits 6 or more years. Furthermore, the Nigerian Society of Engineers (NSE) 30 (28.3%), followed by the Nigerian Institute of Quantity Surveyors (NIQS; 20.8%), the Nigerian Institute of Architects (NIA; 14.2%), and the Nigerian Institute of Builders (NIOB; 13.2%). This shows that 81 (76.4%) respondents were registered with their professional bodies, and 25 (23.6%) were not.

4.2 Level of Cost and Time Overruns on Construction Projects Executed with the Use of TQM Principles in the Imo State Construction Industry.

4.2.1 Level of Cost Overruns on Construction Projects Executed with TOM

Table 1 presents the results of a paired-samples t-test on cost data from construction projects that used TQM. The result shows a statistically significant decrease in the cost of the identified construction projects, from an

average initial estimated cost of ₦99,196,119.05 to an average final cost of ₦98,840,285.71. Statistically, the initial estimated cost exceeds the project's final delivery cost. This is due to the addition of contingencies, which contractors often include to account for unforeseen circumstances. Nevertheless, the result further shows a t-value of -0.516 with a significant p-value of 0.608. This p-value is greater than 0.05, indicating no significant difference in the initial and final construction project costs when using TQM. This means that the difference between the initial estimated cost and the final actual cost is not statistically significant; that is, the cost of TQM-implemented projects lacks deviation from the initial estimate.

4.2.2 Level of Cost Overrun of Construction Project

In Table 2 (Appendix 1), the cost performance of a construction project that applied TQM was analysed using cost data collected from respondents. 42 construction projects were assessed, 6 were completed within the initial estimated cost, 13 were completed below it, and 23 were completed above it. Overall, an average cost savings of N355,833.33 was achieved across all construction projects where TQM was applied. This means that for individual projects carried out by construction firms, cost savings are achieved, and collectively, TQM reduces costs by up to 0.12% across all assessed projects. Thus, applying TQM principles to a project will improve its long-term cost performance by reducing maintenance costs.

‘Note: All figures are rounded off

4.2.3 Level of Time Overruns on Construction Projects Executed with TOM

Table 3 presents the results of a paired-samples t-test on time data collected from construction projects that

Table 1: Paired Sample T-Test for Initial and Final Cost of Construction Projects Executed with the use of TQM

Paired Differences										
		Mean	Average Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
						Lower	Upper			
Pair 1	Final cost	9.8840E7	-3.55833E5	4.46613E6	6.89139E5	-1.74758E6	1.03591E6	-0.516	41	0.608
	Initial Cost	9.9196E7								

Table 3: Paired Sample T-Test for Initial and Final Time of Construction Projects Executed with the use of TQM

Paired Differences										
		Mean	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
						Lower	Upper			
Pair 1	Final time - Initial time	38.83 33.83	5.00	14.05911	2.16937	.61887	9.38113	2.305	41	.026

used TQM. The results show a statistically significant increase in the duration of the identified construction projects, from an average initial estimate of 33.83 weeks to 38.83 weeks. Statistically, the final delivery time exceeds the project's initial estimate. This is due to contractors and construction firms tendering jobs on acceptable delivery schedules to win contracts. Nevertheless, the result further shows a t-value of 2.305 with a significant p-value of 0.026. This p-value is less than 0.05, indicating a significant difference between the initial estimated time and the final delivery time of construction projects using TQM.

Furthermore, Table 4 (Appendix 1) below analyses the time performance of a construction project in which TQM was applied, based on time data collected from respondents. Of the 42 construction projects, 23 were completed within the initial estimate, while 19 were completed after the estimated delivery date. Overall, an average time overrun of 12.31% (5 weeks) was observed across all construction projects assessed that applied TQM principles. This is rather encouraging compared with the significant time overrun experienced in past research. The 12.31% mean time overrun observed in this study is substantially lower than the 188% time overrun reported by Omoregie and Radford (2006) for Nigerian construction projects and the 70% overrun documented by Frimpong et al. (2003) in Ghana. Whether this difference is attributable to TQM application or to other project characteristics, such as project type, procurement practices, or client payment patterns, cannot be determined from this dataset alone, as no non-TQM comparison group was assembled.

4.2.4 Level of Time Overruns on TQM Projects

Findings of this research show a percentage deviation of 12.31% on all assessed TQM projects, as indicated in Table 4. This is far below the 188% time deviation reported by Omoregie and Radford (2006) for construction projects in Nigeria, which indicates poor time performance in projects where TQM principles

were applied. This result aligns with Onifade et al. (2024), who argue that TQM can reduce costs, increase satisfaction, and save time. Frimpong et al. (2003) observed 70% time overruns in 47 projects assessed in Ghana. Based on these studies, it can be concluded that TQM in construction improves time performance compared with conventional systems. Aghimien & Aigbavboa (2018) also find that educational projects funded by TETFunds, Capital Project, and IGR exhibit good cost performance, as no significant differences were observed.

5. Conclusion and Further Studies

The study assessed the performance of construction projects implemented in Imo State, Nigeria, in terms of time and cost, using Total Quality Management (TQM). The paired-samples t-test results showed no statistically significant difference in overall project cost, indicating cost stability. However, a statistically significant time overrun was confirmed with a mean overrun. Although TQM helps enhance control and predictability, time and cost overruns were observed. The cost performance data indicated that projects reportedly using TQM principles were generally delivered within their initial budgets across all 42 assessed projects. This study finds that cost performance on TQM-associated projects was statistically stable and that time overruns, while confirmed, were substantially lower than those documented in prior Nigerian and African construction studies. The study is confined to Imo State. Future studies should adopt a matched-comparative design that pairs TQM and non-TQM projects of a similar type and value and should verify TQM classification through independent site audits or client assessments before extending claims about TQM effectiveness.

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Appendix 1

Table 2: Cost Performance of Construction Projects Executed with the Use of TQM

S/N	Project Type	Final cost (₦)	Initial cost (₦)	Variance (₦)	Percentage
1	Office duplex	350200000.00	348000000.00	2200000.00	0.63
2	Plaza building	173500000.00	173000000.00	500000.00	0.29
3	Etf project	160000000.00	160000000.00	0.00	0.00
4	School office	85000000.00	85200000.00	(200000.00)	-0.23
5	Building construction	980000.00	965000.00	15000.00	1.55
6	Commercial building	7500000.00	7400000.00	100000.00	1.35
7	Building project	850000.00	836000.00	14000.00	1.67
8	School project	15000000.00	15000000.00	0.00	0.00
9	State secretariat building	150000000.00	147000000.00	3000000.00	2.04
10	PHCN main office Owerri	82000000.00	85000000.00	(3000000.00)	-3.53
11	Imo river basin office	30000000.00	29600000.00	400000.00	1.35
12	School project	125500000.00	125000000.00	500000.00	0.40
13	School project	78000000.00	78000000.00	0.00	0.00
14	Building project	65200000.00	65000000.00	200000.00	0.31
15	School project	150000000.00	149500000.00	500000.00	0.33
16	School project	135600000.00	135450000.00	150000.00	0.11
17	Road construction	750000000.00	750015000.00	(15000.00)	0.00
18	Construction works	3472000.00	3469000.00	3000.00	0.09
19	Family house	1200000.00	1200000.00	0.00	0.00
20	Church hall	3500000.00	4200000.00	(700000.00)	-16.67
21	Residential building	6630000.00	6615000.00	15000.00	0.23
22	Farm house	2500000.00	2532000.00	(32000.00)	-1.26
23	Church project	2860000.00	2790000.00	70000.00	2.51
24	School project	37000000.00	37300000.00	(300000.00)	-0.80
25	Shopping complex	28000000.00	28000000.00	0.00	0.00
26	Building project	870000.00	890000.00	(20000.00)	-2.25
27	Building works	10500000.00	10000000.00	500000.00	5.00
28	Government project	220000000.00	216000000.00	400000.00	1.85

S/N	Project Type	Final cost (₦)	Initial cost (₦)	Variance (₦)	Percentage
29	School auditorium	15000000.00	15000000.00	0.00	0.00
30	School office	6500000.00	6700000.00	(200000.00)	-2.99
31	School library (renovation)	3200000.00	3000000.00	200000.00	6.67
32	School gate (renovation)	1780000.00	1700000.00	80000.00	4.71
33	School project	30000000.00	29800000.00	200000.00	0.67
34	Owerri / onitsha road	758600000.00	758300000.00	300000.00	0.04
35	Renovation project	16000000.00	16500000.00	(500000.00)	-3.03
36	New building project	78000000.00	77600000.00	400000.00	0.52
37	Office building	150000000.00	150700000.00	(700000.00)	-0.46
38	Office block	2100000.00	2000000.00	100000.00	5.00
39	Renovation of zonal office	46000000.00	41000000.00	5000000.00	12.20
40	Rotary club office	7600000.00	7800000.00	(200000.00)	-2.56
41	Building	650000.00	675000.00	(25000.00)	-3.70
42	Building renovation	360000000.00	387500000.00	(27500000.00)	-7.10
				(₦ 355833.33)	0.12

Table 4: Time Performance of Construction Projects Executed with the Use of TQM

S/N	Project type	Final time (Weeks)	Initial time (Weeks)	Variance (Weeks)	Percentage
1	Office duplex	144	140	4	2.86
2	Plaza building	24	24	0	0.00
3	Etf project	42	42	0	0.00
4	School office	24	24	0	0.00
5	Building construction	32	30	2	6.67
6	Commercial building	128	58	70	120.69
7	Building project	12	12	0	0.00
8	School project	24	24	0	0.00
9	State secretariat building	96	48	48	100.00
10	PHCN main office Owerri	32	32	0	0.00
11	Imo river basin office	24	24	0	0.00
12	School project	56	52	4	7.69
13	School project	24	23	1	4.35
14	Building project	32	32	0	0.00
15	School project	36	35	1	2.86
16	School project	24	24	0	0.00
17	Road construction	64	62	2	3.23
18	Construction works	42	40	2	5.00
19	Family house	36	36	0	0.00
20	Church hall	28	28	0	0.00
21	Residential building	30	29	1	3.45
22	Farm house	24	24	0	0.00
23	Church project	44	24	20	83.33
24	School project	36	30	6	20.00
25	Shopping complex	24	22	2	9.09
26	Building project	24	23	1	4.35
27	Building works	24	24	0	0.00
28	Government project	64	64	0	0.00
29	School auditorium	24	24	0	0.00
30	School office	24	23	1	4.35
31	School library (renovation)	24	22	2	9.09

S/N	Project type	Final time (Weeks)	Initial time (Weeks)	Variance (Weeks)	Percentage
32	School gate (renovation)	24	24	0	0.00
33	School project	24	22	2	9.09
34	Owerri / onitsha road	20	20	0	0.00
35	Renovation project	36	36	0	0.00
36	New building project	35	32	3	9.38
37	Office building	72	34	38	111.76
38	Office block	38	38	0	0.00
39	Renovation of zonal office	48	48	0	0.00
40	Rotary club office	24	24	0	0.00
41	Building	12	12	0	0.00
42	Building renovation	32	32	0	0.00
				5.00 (Weeks)	12.31