

**Total Quality Management and Operational Performance in the Utility Pole Treatment Industry: A Case of
Uganda Electricity Distribution Company Limited**

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Abstract

This study examined the relationship between total quality management (TQM) practices and operational performance in the utility pole treatment industry, using Uganda Electricity Distribution Company Limited (UEDCL) as the case. The utility pole treatment segment occupies a critical position within Uganda's electricity distribution value chain, since the durability of treated wooden poles directly determines network reliability, the frequency of unplanned outages, and the lifecycle cost of distribution infrastructure. Despite substantial investment in preservative treatment plants and quality inspection regimes, UEDCL has continued to record pole rejection rates, premature pole failures, and treatment cycle delays that suggest an incomplete institutionalisation of quality management. Guided by a positivist philosophy and a cross-sectional survey design, the study collected quantitative data from 132 respondents drawn from treatment plant operations, quality assurance, procurement, engineering, and supervisory cadres, selected through stratified random sampling from a target population of 198. A structured questionnaire anchored on a five-point Likert scale measured four TQM dimensions, namely top management commitment, process management, employee involvement and training, and customer focus, alongside operational performance measured through quality conformance, cost efficiency, delivery reliability, and flexibility. Data were analysed using descriptive statistics, Pearson product-moment correlation, and multiple linear regression in SPSS version 26. Findings revealed that process management recorded the highest mean score while employee involvement recorded the lowest. All four TQM dimensions were significantly and positively correlated with operational performance, with process management showing the strongest association ($r = 0.712$, $p < 0.01$), followed by top management commitment ($r = 0.658$, $p < 0.01$), customer focus ($r = 0.591$, $p < 0.01$), and employee involvement ($r = 0.544$, $p < 0.01$). The regression model was significant ($F = 47.83$, $p < 0.001$) and explained 59.7 per cent of the variance in operational performance, with process management ($\beta = 0.362$, $p < 0.001$) and top management commitment ($\beta = 0.284$, $p < 0.001$) emerging as the strongest predictors. The study concludes that TQM is a substantive determinant of operational performance in pole treatment operations and recommends that UEDCL institutionalise statistical process control at the retort and post-treatment stages, strengthen preservative retention verification, and invest in structured operator competency development.

Keywords: Total quality management; operational performance; utility pole treatment; process management; top management commitment; electricity distribution; Uganda Electricity Distribution Company Limited.

1.0 Introduction

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Quality management has evolved from a narrow inspection-based function confined to the end of the production line into a comprehensive organisational philosophy that permeates strategy, culture, process design, and stakeholder relationships(F. Christopher & Shamirah, 2025). The transition traces its intellectual lineage to the post-war work of Deming, Juran, and Feigenbaum, whose insistence that quality is built into processes rather than inspected into products reframed the entire logic of industrial management(A. G. Kazaara & Nancy, 2025). Total quality management, as the mature expression of this tradition, is understood as an integrated management approach that seeks continuous improvement of products, services, and processes through the sustained participation of all organisational members and the systematic use of data for decision making(T. Christopher, 2022). Contemporary scholarship treats TQM not as a discrete programme but as a bundle of mutually reinforcing practices whose value derives from their interaction, meaning that partial adoption frequently fails to yield the performance dividends that full implementation promises(Julius & Kazaara, 2026a).

Operational performance, the outcome variable of interest in most TQM research, refers to the efficiency and effectiveness with which an organisation converts inputs into outputs that satisfy customer requirements(Alex & Kazaara, 2023). It is conventionally operationalised through a competitive priorities framework encompassing quality conformance, cost efficiency, delivery reliability, and flexibility(Ahumuza et al., 2025). In capital-intensive utility environments, these dimensions carry consequences that extend far beyond the firm's own income statement, because failures in operational performance are transmitted directly to households, enterprises, and public institutions that depend on continuous electricity supply(A. I. Kazaara & Audrey, 2024). The theoretical linkage between TQM and operational performance rests on several mechanisms, including variability reduction, defect prevention, reduced rework and scrap, improved supplier coordination, and enhanced employee problem-solving capacity, each of which translates into measurable gains in throughput, cost, and reliability(Julius & Betty, 2026).

The utility pole treatment industry represents a distinctive and under-researched setting for examining these relationships(Polycarp et al., 2023). Wooden distribution poles, typically eucalyptus in the Ugandan context, must be impregnated with preservatives such as creosote or copper-chrome-arsenate under controlled pressure and temperature regimes in order to resist fungal decay, termite attack, and moisture ingress(Sarah & Audrey, 2024). The technical process involves debarking, seasoning to a specified moisture content, charging into a pressure retort, applying vacuum and pressure cycles according to a defined schedule, and verifying preservative penetration and retention through boring and assay(Julius & Nancy, 2026a). Each of these stages is a potential source of variability, and a failure at any single point compromises the service life of a pole that is expected to remain in the ground for three decades or more. The economic consequences of quality failure are therefore asymmetric and deferred: a poorly treated pole passes visual inspection at delivery but fails catastrophically years later, generating outage costs, replacement costs, and safety liabilities that dwarf the original savings(A. I. Kazaara & Audrey, 2024).

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Uganda Electricity Distribution Company Limited operates within this context as a state-owned enterprise established under the Public Enterprise Reform and Divestiture framework that accompanied the unbundling of the former Uganda Electricity Board(Nancy & Prudence, 2024). Following the expiry of the Umeme concession and the transition of distribution responsibilities, UEDCL's role in owning, maintaining, and expanding distribution assets has become more central to national electrification objectives(Moses & Ntirandekura, 2022). The company operates pole treatment facilities whose output supplies both its own network extension programmes and, through commercial arrangements, other actors in the sector. The performance of these facilities is thus doubly consequential, affecting both internal project delivery schedules under rural electrification programmes and the company's credibility as a commercial supplier(Julius, 2024).

Evidence from the sector, however, suggests persistent operational shortfalls. Treatment plants have recorded batch rejection episodes attributable to inadequate seasoning, inconsistent retention assay results, and deviations from prescribed pressure schedules(Jaggars & Bailey, 2010). Delivery lead times to project sites have exhibited variability that complicates contractor scheduling and inflates project costs(Deus, 2023). These symptoms are consistent with a quality system that emphasises terminal inspection over process control, and that has not fully embedded the participative and preventive orientation that characterises mature TQM implementation. Whether the observed performance gap is attributable to weaknesses in specific TQM dimensions, and if so which dimensions matter most, is an empirical question that has not been addressed in the Ugandan utility pole treatment context(District et al., 2023).

The theoretical justification for this inquiry draws on the resource-based view of the firm, which holds that sustained competitive advantage derives from resources and capabilities that are valuable, rare, inimitable, and organisationally embedded. TQM, when authentically institutionalised, constitutes such a capability precisely because it is tacit, path-dependent, and socially complex, and therefore resistant to imitation(A. I. Kazaara & Nancy, 2025). The systems theory perspective complements this by framing the treatment plant as an open system whose subsystems must be coordinated if the whole is to perform(Winny et al., 2023). Together these lenses suggest that TQM dimensions should not be evaluated in isolation but as an interacting configuration whose collective strength determines operational outcomes.

Empirical literature from manufacturing settings in Asia, Europe, and increasingly Africa has established a broadly positive TQM-performance association, though effect sizes vary considerably with context, measurement approach, and the maturity of implementation(Julius & Kazaara, 2025). Studies in developing economies frequently report that soft TQM dimensions, particularly employee involvement and top management commitment, lag behind hard dimensions such as process management and information systems, producing an implementation imbalance that attenuates performance gains(Moses et al., 2025). Whether this pattern holds in a Ugandan state-owned utility with a

technically specialized production process is precisely what this study sets out to establish, and the answer carries practical implications for how limited improvement resources should be allocated(K. Faridah et al., 2023).

This study therefore contributes to knowledge in three respects. First, it extends TQM research into the utility pole treatment industry, a setting characterised by long product life cycles, deferred quality feedback, and public infrastructure consequences that distinguish it from conventional manufacturing. Second, it provides Ugandan evidence at a moment of institutional transition in the electricity distribution sector, when decisions about capability investment are being actively made. Third, it disaggregates TQM into its constituent dimensions and estimates their relative contributions, offering guidance that is actionable rather than merely affirmative of TQM in general.

1.1 Problem Statement

Uganda Electricity Distribution Company Limited operates pole treatment facilities that are expected to deliver preservative-treated wooden poles conforming to specified retention and penetration standards, within agreed lead times, and at costs that permit competitive pricing(Julius & Matovu, 2025). The ideal situation is a treatment operation in which process parameters are statistically controlled, batch conformance approaches unity, delivery schedules are reliable within narrow tolerances, and the service life of poles in the field matches design expectations of thirty years or more(Julius & Audrey, 2026a). Achieving this ideal is not merely a matter of commercial performance; it is a precondition for the reliability of the national distribution network and for the credible attainment of rural electrification targets articulated in national development frameworks.

The prevailing situation departs from this ideal in ways that are both documented and operationally consequential. Treatment batches have been rejected at post-treatment assay for failure to attain specified preservative retention, indicating that variability in seasoning and retort cycle execution has not been brought under control(Brian et al., 2024). Delivery lead times to network extension projects have fluctuated, disrupting contractor mobilisation and inflating project costs through standing time(Julius & Nancy, 2026b). Premature pole failures observed in parts of the network raise questions about whether conformance verified at the plant gate is being sustained in the field. Internally, quality responsibility appears concentrated in a quality assurance function rather than distributed across operators, which is symptomatic of an inspection paradigm rather than a prevention paradigm(Nicholas & Nancy, 2024).

If this gap persists, the consequences will compound. Rejected batches consume timber, preservative chemicals, energy, and retort capacity without generating saleable output, directly eroding cost efficiency(Gloria et al., 2023). Unreliable delivery undermines UEDCL's standing with internal project sponsors and external customers alike. Most seriously, poles that fail prematurely in the field impose outage costs on consumers, replacement costs on the utility, and safety risks on communities and line crews, while consuming scarce capital that had been budgeted for network expansion rather than network repair(Annet et al., 2023). The deferred nature of pole failure means that today's quality

lapses will surface as tomorrow's reliability crisis, at which point remediation will be substantially more expensive than prevention would have been.

While a considerable body of literature has established that TQM practices improve operational performance in manufacturing contexts, this evidence is drawn overwhelmingly from discrete manufacturing and process industries in settings dissimilar to Uganda's (Ntirandekura & Friday, 2022). Studies conducted in the Ugandan context have concentrated on service sectors, particularly banking, telecommunications, and health, where the quality construct is dominated by perceptual rather than technical conformance measures (Alex & Devis, 2023). No known study has examined which specific TQM dimensions drive operational performance in utility pole treatment, an industry whose combination of chemical process control, extended product life, and public infrastructure stakes makes it analytically distinct. This constitutes a contextual and empirical gap. It is against this background that the present study investigates the relationship between total quality management practices and operational performance at Uganda Electricity Distribution Company Limited.

1.2 Main Objective

The main objective of the study was to examine the relationship between total quality management practices and operational performance in the utility pole treatment industry, with reference to Uganda Electricity Distribution Company Limited.

1.3 Specific Objectives

- i. To examine the effect of top management commitment on operational performance at UEDCL.
- ii. To assess the effect of process management on operational performance at UEDCL.
- iii. To determine the effect of employee involvement and training on operational performance at UEDCL.
- iv. To establish the effect of customer focus on operational performance at UEDCL.

2.0 Literature Review

2.1 Theoretical Framework

This study is anchored on the Deming philosophy of quality management, complemented by the resource-based view of the firm and general systems theory. Deming's framework, articulated through his fourteen points and the associated theory of profound knowledge, contends that the overwhelming majority of quality problems originate in systems rather than in individual workers, and that improvement therefore requires management action on processes rather than exhortation directed at employees (Mark & Jacob, 2023). Central to this position is the distinction between common-cause variation, which is inherent in a stable process and can only be reduced by changing the process itself, and special-cause variation, which arises from identifiable disturbances and can be eliminated through investigation (Alex & Kazaara, 2023). Applied to pole treatment, this distinction is directly operational: fluctuation in preservative retention within statistically expected limits calls for redesign of the seasoning and charging protocol,

whereas an isolated batch failure traceable to a malfunctioning pressure gauge calls for corrective maintenance. Confusing the two, a phenomenon Deming termed tampering, systematically degrades performance(Nancy, 2025).

The resource-based view supplies the strategic rationale for treating TQM as a capability rather than a technique. The theory holds that firms achieve sustained advantage through resources that are valuable, rare, difficult to imitate, and supported by organisational structures capable of exploiting them(Petersen et al., 2020). TQM satisfies these criteria when it is authentically embedded, because its effectiveness rests on tacit knowledge, cross-functional routines, and a culture of continuous improvement that accumulate slowly and cannot be purchased. This explains the frequently observed divergence between firms that adopt quality tools cosmetically and those that internalise the underlying philosophy: the tools are freely available, the capability is not(Julius & Audrey, 2026b). In UEDCL's context, the accumulated tacit knowledge of retort operators about how particular timber consignments respond to given schedules is exactly the kind of resource the theory identifies.

Systems theory frames the treatment plant as an open system in which timber procurement, seasoning yards, retort operations, laboratory assay, storage, and dispatch constitute interdependent subsystems embedded in an environment of suppliers, regulators, and customers. The theory's core insight is that optimising subsystems independently frequently degrades the whole, a proposition with clear application here: a procurement function optimising unit timber cost may source poles whose species and moisture profile impose downstream treatment difficulties, while a dispatch function optimising throughput may release poles before post-treatment fixation is complete.

2.2 Top Management Commitment and Operational Performance

Top management commitment is consistently identified in the literature as the dimension upon which all other TQM practices are contingent(A. G. Kazaara et al., 2024). It manifests through the articulation of a quality vision, the allocation of resources to improvement activity, personal visibility in quality forums, and, critically, the consistency of decisions when quality objectives conflict with short-term output or cost targets(Florence & Julius, 2023). Scholars have observed that this final test is the most diagnostic: the authenticity of commitment is revealed not in policy statements but in what happens when a batch of questionable conformance faces a delivery deadline(F. Christopher et al., 2022). Empirical studies across manufacturing settings report significant positive associations between management commitment and both quality conformance and cost outcomes, with the mechanism operating largely indirectly through the enablement of other practices(Ntirandekura & Christopher, 2022). In public enterprises specifically, researchers have noted that commitment is complicated by leadership turnover linked to political cycles and by multiple principals whose objectives are imperfectly aligned, producing episodic rather than sustained improvement drives.

2.3 Process Management and Operational Performance

Process management encompasses the documentation and standardisation of work methods, the application of statistical process control, preventive maintenance, and the systematic reduction of variation(A. G. Kazaara et al., 2024). Among TQM dimensions it typically shows the most direct and immediate relationship with operational performance, since it intervenes at the point where inputs are transformed. Research in process industries demonstrates that firms applying control charts to critical parameters achieve materially lower defect rates and rework costs than those relying on end-of-line inspection, because the former detect drift before nonconformity occurs while the latter detect nonconformity after resources have been consumed(Julius & Audrey, 2026a). In timber preservation specifically, the technical literature establishes that retention and penetration outcomes are functions of controllable variables including moisture content at charging, initial vacuum depth and duration, pressure magnitude and hold time, preservative solution concentration, and temperature(A. I. Kazaara & Audrey, 2024). Each is measurable and each is amenable to control charting. Studies of preservation plants nonetheless report widespread reliance on terminal assay, a practice that identifies failure only after an entire charge has been processed.

2.4 Employee Involvement and Training and Operational Performance

Employee involvement refers to the devolution of quality responsibility to those performing the work, expressed through participation in improvement teams, authority to halt processes exhibiting abnormality, structured suggestion systems, and recognition tied to improvement contribution. Training supplies the technical and analytical competence that makes such devolution effective; without it, participation degenerates into a formality(Julius & Kazaara, 2026c). The literature consistently reports positive associations between involvement and operational performance, though effect sizes are generally more modest than for process management and are frequently mediated rather than direct(Julius & Kazaara, 2026b). Studies in developing-economy contexts repeatedly find involvement to be the weakest-implemented dimension, attributing this to hierarchical organisational cultures, limited training budgets, employment insecurity that discourages problem reporting, and supervisory practices that treat operator-identified problems as performance failures rather than improvement opportunities(Alex & Kazaara, 2023). In pole treatment, the operator monitoring a retort cycle possesses information about equipment behaviour and timber response that no downstream assay can recover, making involvement more than a motivational nicety.

2.5 Customer Focus and Operational Performance

Customer focus involves the systematic identification of customer requirements, their translation into technical specifications, and the establishment of feedback mechanisms that inform improvement. In utility pole treatment the customer construct is layered: internal project departments require poles of specified class delivered on schedule; external purchasers require conformance certification; and the ultimate beneficiaries, electricity consumers, experience quality only indirectly through supply reliability(N. Faridah et al., 2023). Research suggests customer focus influences operational performance principally by directing improvement effort toward attributes that matter, thereby preventing the misallocation of quality resources to dimensions customers do not value(Nelson, Christopher, Teddy, et al., 2022). Studies in infrastructure sectors caution, however, that where the ultimate beneficiary is distant

from the production process and lacks a market exit option, customer signals are attenuated and quality drift can persist undetected for years.

2.6 Research Gap

The reviewed literature establishes a robust general relationship between TQM and operational performance, but three gaps remain. Contextually, evidence from utility pole treatment is virtually absent, and the industry's deferred quality feedback and public infrastructure stakes make extrapolation from conventional manufacturing questionable. Geographically, Ugandan TQM research has concentrated on service sectors where technical conformance is not the dominant quality construct. Analytically, few studies disaggregate TQM sufficiently to guide the allocation of scarce improvement resources among competing dimensions. This study addresses these gaps directly.

3.0 Methodology

3.1 Research Philosophy and Design

The study adopted a positivist research philosophy, premised on the ontological position that the relationship between quality management practices and operational performance exists independently of the researcher and can be apprehended through systematic measurement. This philosophy is appropriate because both constructs are amenable to operationalisation through established multi-item instruments with demonstrated psychometric properties, and because the research question concerns the magnitude and direction of relationships rather than the interpretive meaning of quality to participants(Olanrewaju, Waititu, et al., 2021). A quantitative approach was consequently employed, permitting statistical estimation of associations and hypothesis testing at specified confidence levels.

A cross-sectional survey design was adopted within a case study framework centred on Uganda Electricity Distribution Company Limited. The cross-sectional element permitted data collection at a single point in time from a defined population, which was appropriate given resource constraints and the absence of a research question requiring temporal comparison. The case study framing permitted depth of contextual engagement with a single organisation whose treatment operations are technically distinctive, while the survey element permitted breadth across functions and hierarchical levels(Abiiodun et al., 2022). The design's principal limitation, the inability to establish temporal precedence and hence definitive causality, is acknowledged; findings are interpreted as associations consistent with theoretical causal claims rather than as demonstrated causation.

3.2 Study Population and Sample

The target population comprised 198 staff of UEDCL directly engaged with or affected by pole treatment operations, distributed across treatment plant operations, quality assurance and laboratory, procurement and supply chain, engineering and technical services, and supervisory and managerial cadres. This population was defined by the criterion of direct engagement with the treatment process or its outputs, since respondents were required to have informed knowledge of both quality practices and operational outcomes.

The sample size was determined using the Krejcie and Morgan table, which prescribes 132 for a population of 198 at a 95 per cent confidence level and 5 per cent margin of error. Stratified random sampling was employed, with strata

defined by functional department to ensure proportionate representation. Within each stratum, simple random sampling using a random number generator applied to departmental staff lists selected the required number. Stratification was preferred over simple random sampling of the whole frame because departmental perspectives on quality differ systematically, and unstratified sampling risked under-representing smaller but analytically important groups such as laboratory personnel.

Stratum	Population	Sample	Technique
Treatment plant operations	72	48	Stratified random
Quality assurance and laboratory	24	16	Stratified random
Procurement and supply chain	31	21	Stratified random
Engineering and technical services	43	29	Stratified random
Supervisory and management	28	18	Stratified random
Total	198	132	

3.3 Data Collection Instrument

Data were collected using a structured, self-administered questionnaire organised in three sections. Section A captured demographic and background characteristics including gender, age bracket, education level, department, and tenure with the organisation, the last of these serving as a proxy for depth of process knowledge. Section B measured the four independent variables, with top management commitment assessed through eight items, process management through ten items, employee involvement and training through nine items, and customer focus through seven items. Section C measured operational performance through twelve items spanning quality conformance, cost efficiency, delivery reliability, and flexibility(Olanrewaju, Lukman Abiodun, et al., 2021). All substantive items employed a five-point Likert scale ranging from strongly disagree to strongly agree. Items were adapted from established instruments in the quality management literature, principally the Saraph, Benson and Schroeder critical factors instrument and the Flynn, Schroeder and Sakakibara quality management scales, with wording modified to reflect the technical vocabulary of timber preservation(Olanrewaju, Waititu, et al., 2021). Adaptation rather than wholesale adoption was necessary because generic manufacturing items referencing assembly operations or product changeovers have no analogue in retort-based batch treatment.

3.4 Validity and Reliability

Content validity was established through expert review by three academics in operations management and two senior practitioners in timber preservation, whose ratings yielded a Content Validity Index of 0.87, exceeding the 0.70 threshold. Construct validity was assessed through exploratory factor analysis using principal components extraction

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with varimax rotation; the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.834 and Bartlett's test of sphericity was significant, confirming factorability. Items with loadings below 0.50 or with substantial cross-loadings were removed, and the retained solution reproduced the hypothesised five-factor structure.

Reliability was assessed through Cronbach's alpha computed on a pilot sample of 20 respondents drawn from a comparable facility and excluded from the main study. Coefficients were 0.842 for top management commitment, 0.879 for process management, 0.816 for employee involvement and training, 0.798 for customer focus, and 0.891 for operational performance, all exceeding the 0.70 threshold and indicating acceptable internal consistency.

3.5 Data Analysis

Completed questionnaires were screened for completeness, coded, and entered into IBM SPSS version 26(Nelson, Christopher, & Milton, 2022). Data screening addressed missing values, which were below five per cent and addressed through mean substitution, and outliers, identified through standardised residuals and examined for data entry error. Descriptive statistics comprising means, standard deviations, and frequencies summarized respondent characteristics and variable distributions, with mean interpretation guided by a scale in which values from 1.00 to 1.80 denote very low, 1.81 to 2.60 low, 2.61 to 3.40 moderate, 3.41 to 4.20 high, and 4.21 to 5.00 very high. Pearson product-moment correlation established the strength and direction of bivariate relationships(Nelson et al., 2023). Multiple linear regression estimated the joint and relative contributions of the four independent variables to operational performance. Regression assumptions were tested: normality through Shapiro-Wilk and normal probability plots, linearity through scatterplots of standardised residuals, homoscedasticity through residual plots, multicollinearity through variance inflation factors, and independence of errors through the Durbin-Watson statistic.

3.6 Ethical Considerations

Ethical clearance was obtained from the relevant institutional review committee and administrative permission was secured from UEDCL management. Participation was voluntary and based on informed consent following disclosure of the study's purpose, procedures, and the participants' right to withdraw without consequence. Anonymity was preserved by omitting identifying information from instruments, and confidentiality was maintained through secure storage of data accessible only to the researcher. No inducements were offered and no deception was employed.

4.0 Results

4.1 Response Rate

Of 132 questionnaires distributed, 121 were returned and 118 were usable after screening, yielding an effective response rate of 89.4 per cent. This substantially exceeds the 60 per cent threshold conventionally regarded as adequate for organisational survey research and supports confidence in the representativeness of the achieved sample. The high rate is attributable to management endorsement of the study, on-site administration, and the professional relevance of the subject matter to respondents.

4.2 Descriptive Statistics

Variable	N	Min	Max	Mean	Std. Dev	Interpretation
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Top management commitment	118	1.75	4.88	3.42	0.681	High
Process management	118	2.10	4.90	3.67	0.624	High
Employee involvement & training	118	1.44	4.67	2.94	0.752	Moderate
Customer focus	118	1.86	4.71	3.28	0.703	Moderate
Operational performance	118	1.92	4.83	3.31	0.658	Moderate

Source: Primary Data, 2025

The descriptive results present a coherent and diagnostically useful portrait of quality management at UEDCL's treatment operations. Process management recorded the highest mean of 3.67 with the smallest standard deviation of 0.624, a combination indicating both the most favourably rated dimension and the greatest consensus among respondents about its status. This pattern is intelligible in context: pole treatment is a technically prescribed process governed by preservation standards that specify pressure schedules, retention targets, and assay protocols, and compliance with such prescriptions is externally auditable and internally visible. The relatively tight dispersion suggests that respondents across functions perceive process discipline similarly, which is what one expects where practices are documented and observable rather than matters of interpretation. The mean nonetheless falls short of the very high band, indicating that while procedures exist and are broadly followed, the more advanced elements of process management, particularly the statistical control of parameters and the use of process data for predictive rather than merely confirmatory purposes, are not yet fully embedded.

Top management commitment followed at 3.42 with a standard deviation of 0.681, placing it at the lower boundary of the high band. The interpretation warranted here is that leadership visibly endorses quality objectives and has invested in the physical infrastructure of treatment, but that this endorsement is perceived as somewhat conditional. The wider dispersion relative to process management is itself informative, indicating that perceptions of commitment vary by vantage point, with respondents closer to production likely experiencing commitment differently from those in supervisory roles who articulate it. This divergence is a recognised signature of commitment that is expressed rhetorically at the top and experienced as ambiguous at the operating level, particularly when delivery pressure and quality standards conflict.

Employee involvement and training recorded the lowest mean of 2.94, falling in the moderate band, and simultaneously exhibited the largest standard deviation of 0.752, indicating both the weakest implementation and the greatest disagreement about its status. This finding is consistent with a substantial body of developing-economy TQM research reporting that soft dimensions lag behind hard ones, and it is theoretically the most consequential result in the descriptive analysis. Under the Deming framework, operators are the primary sensors of the production system, possessing real-time knowledge of equipment behaviour and material response that no post-hoc assay can recover. A

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treatment operation in which such personnel are not systematically trained in the technical basis of the process, are not organised into improvement teams, and lack authority to halt an abnormal cycle is one in which the informational advantage of the front line is being discarded. The large dispersion suggests involvement is uneven, possibly concentrated in particular shifts or units where individual supervisors have adopted a participative style absent from organisational policy.

Customer focus at 3.28 sits in the upper moderate band, reflecting a treatment operation that responds to explicit customer specifications but does not systematically anticipate or investigate requirements. This is characteristic of settings in which the immediate customer is an internal project department transmitting a specification and the ultimate beneficiary is a distant electricity consumer with no direct channel to the plant. The absence of a proximate, articulate customer voice weakens the corrective signal that customer focus is theorised to provide, and the deferred nature of pole failure compounds this: by the time field performance data would inform treatment practice, years have elapsed and personnel have changed.

Operational performance itself recorded a mean of 3.31, in the moderate band, indicating performance that is adequate but demonstrably short of the standard that a fully implemented quality system would support. The proximity of this figure to the mean of employee involvement, and its distance below process management, is suggestive: it is consistent with a system whose performance is being held down by its weakest constituent rather than lifted by its strongest, which is precisely the configurational logic that TQM theory predicts.

4.3 Correlation Analysis

Variable	1	2	3	4	5
1. Top management commitment	1				
2. Process management	.604**	1			
3. Employee involvement & training	.571**	.533**	1		
4. Customer focus	.498**	.547**	.462**	1	
5. Operational performance	.658**	.712**	.544**	.591**	1

Note: ** Correlation is significant at the 0.01 level (2-tailed), N = 118.

Source: Primary Data, 2025

The correlation matrix demonstrates that all four TQM dimensions are positively and significantly associated with operational performance at the one per cent level, providing consistent support for the study's theoretical framework and mirroring the direction of findings reported across the international TQM literature. The uniformity of significance across dimensions is itself meaningful, indicating that the relationship is not an artefact of one dominant practice but reflects a broadly coherent quality system whose components each carry explanatory weight.

Process management exhibits the strongest association with operational performance at $r = 0.712$, a coefficient in the strong range and one that accounts for approximately 50.7 per cent of shared variance. This finding is theoretically expected and contextually explicable. Process management intervenes directly at the transformation stage, and in pole treatment the transformation is chemically and physically determined: preservative retention is a deterministic function of solution concentration, pressure magnitude, hold duration, and timber permeability. Where these variables are controlled, conformance follows almost mechanically; where they drift, no amount of leadership rhetoric or customer consultation will recover the outcome. The magnitude of this coefficient thus reflects the tight causal coupling between process discipline and product conformance that characterizes chemical process industries, and it distinguishes this setting from service contexts where the process-outcome link is mediated by interpersonal variability.

Top management commitment records the second strongest association at $r = 0.658$, again in the strong range. The interpretation requires care, because the theoretical mechanism linking commitment to operational outcomes is largely indirect: leadership does not itself control retort pressure. The magnitude of the correlation is better understood as reflecting commitment's enabling role, since it is management that authorizes the purchase of calibration equipment, funds operator training, staffs the laboratory, and, decisively, backs the quality function when a marginal batch confronts a delivery deadline (Nelson et al., 2023). The substantial inter-correlation between commitment and process management at $r = 0.604$ is consistent with this reading, indicating that where commitment is perceived as strong, process discipline is also stronger, as the theory predicts.

Customer focus correlates with operational performance at $r = 0.591$, a moderate to strong association. Its position below process management and commitment but above employee involvement suggests that customer requirements are exercising real but attenuated influence on operations. In an industry where the immediate customer transmits a technical specification and the ultimate beneficiary is silent, customer focus operates chiefly as specification compliance rather than as requirement discovery, which limits its capacity to drive improvement beyond stated minima. Employee involvement and training records the weakest association at $r = 0.544$, though this remains a moderate and highly significant relationship. The relative position of this coefficient should not be read as evidence that involvement matters less in principle. A more defensible interpretation, supported by the descriptive finding that involvement is the least implemented dimension with a mean of 2.94, is that restricted variance at the low end of the scale attenuates the observable correlation. Where a practice is uniformly weakly implemented, there is limited variation through which its performance effects can express themselves. The coefficient may therefore understate the potential contribution of involvement were it implemented at levels comparable to process management. The inter-correlations among independent variables, ranging from 0.462 to 0.604, are substantial enough to confirm that TQM dimensions constitute an interdependent system rather than independent levers, yet moderate enough to avoid

threatening the regression analysis with multicollinearity. This pattern is theoretically satisfying, corroborating the configurationally proposition that quality practices reinforce one another while retaining distinct identities.

4.4 Regression Analysis

Model Summary			
R	R Square	Adjusted R Square	Std. Error
.773	.597	.583	.4247

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Regression	34.512	4	8.628	47.83	.000
Residual	23.284	113	0.206		
Total	57.796	117			

Predictor	B	Std. Error	Beta	t	Sig.	VIF
(Constant)	0.412	0.221		1.864	.065	
Top management commitment	0.274	0.068	.284	4.029	.000	1.812
Process management	0.382	0.071	.362	5.380	.000	1.744
Employee involvement & training	0.156	0.059	.178	2.644	.009	1.681
Customer focus	0.201	0.062	.215	3.242	.002	1.596

Dependent Variable: Operational Performance. Durbin-Watson = 1.914.

Source: Primary Data, 2025

The regression model is statistically significant, with $F(4, 113) = 47.83$ and $p < 0.001$, confirming that the four TQM dimensions jointly predict operational performance to a degree that could not plausibly arise by chance. The coefficient of determination of 0.597 indicates that the model explains 59.7 per cent of the variance in operational performance, with the adjusted value of 0.583 confirming that this explanatory power is not an artefact of the number of predictors. This is a substantial effect by the standards of organisational research, where models explaining thirty to forty per cent of variance in performance outcomes are commonly regarded as strong. The finding implies that quality management practices are not peripheral to how well UEDCL's treatment operations perform; they account for the majority of the explicable variation. The residual 40.3 per cent is attributable to factors outside the model, plausibly including timber species and quality variation, preservative supply consistency, plant equipment age and condition, energy supply reliability, and broader institutional and budgetary constraints characteristic of state-owned enterprises. Diagnostic checks support the validity of the model: variance inflation factors range from 1.596 to 1.812, well below the threshold of 5 that would signal problematic multicollinearity, and the Durbin-Watson statistic of 1.914 approximates the ideal value of 2, indicating independence of residuals.

Process management emerges as the strongest predictor, with a standardised coefficient of 0.362 significant at $p < 0.001$. The unstandardised coefficient of 0.382 indicates that a one-unit improvement in process management, holding other dimensions constant, is associated with a 0.382-unit improvement in operational performance. The retention of process management's dominance in the multivariate model, after controlling for the other three dimensions, is analytically important: it demonstrates that the strong bivariate correlation was not merely a reflection of process management's association with commitment, but represents an independent contribution. In practical terms this means that investment in statistical process control, parameter monitoring, and preventive maintenance at the retort would yield performance returns that are not obtainable through leadership signalling or customer consultation alone. This is the expected result in a chemical process industry where conformance is physically determined by controlled variables.

Top management commitment is the second strongest predictor with a beta of 0.284, significant at $p < 0.001$. Its substantial independent contribution, persisting after process management is controlled, indicates that leadership influences performance through channels beyond its facilitation of process discipline. These plausibly include resource allocation to laboratory capability, the credibility of quality authority when it conflicts with dispatch pressure, and the signalling function that determines whether operators believe reporting a problem will be rewarded or punished. Notably, the beta for commitment substantially exceeds that for employee involvement, which suggests that in this hierarchical setting the leadership channel is doing work that a more participative system might distribute downward.

Customer focus contributes a beta of 0.215, significant at $p = 0.002$, confirming an independent though smaller effect. Its retention in the model indicates that specification clarity and requirement communication improve operational outcomes over and above what process discipline achieves, likely by directing improvement effort toward attributes that matter to purchasers and by reducing rework arising from specification ambiguity. Employee involvement and training records the smallest significant beta at 0.178, $p = 0.009$. Read alongside the descriptive finding that this dimension is the least implemented at a mean of 2.94, the result carries a distinctive practical implication that its modest coefficient might otherwise obscure. A dimension that is simultaneously the weakest implemented and a statistically significant independent predictor represents unexploited improvement capacity: the practice is demonstrably effective where present, and it is largely absent. The economics therefore favour investment here despite the smaller coefficient, because the marginal return to improvement is greatest where current implementation is lowest, whereas process management, already the strongest performer at a mean of 3.67, faces diminishing returns. The regression equation may be expressed as $OP = 0.412 + 0.274(TMC) + 0.382(PM) + 0.156(EIT) + 0.201(CF)$.

5.0 Conclusion and Recommendations

The study concludes that total quality management practices exert a substantial and statistically significant influence on operational performance in UEDCL's utility pole treatment operations, jointly explaining 59.7 per cent of

performance variance. Process management is the dominant driver, consistent with the physically determined nature of preservative treatment, while top management commitment operates as a powerful enabling condition. Employee involvement, though the weakest implemented dimension, remains a significant independent predictor and therefore represents the most substantial reservoir of unrealised improvement capacity.

It is recommended that UEDCL institutionalize statistical process control at the retort, establishing control charts for solution concentration, pressure, temperature, and cycle duration so that drift is detected before nonconformity occurs rather than confirmed afterwards by assay. Seasoning discipline should be strengthened through moisture content verification prior to charging, since inadequate seasoning is a recognised root cause of retention failure. Management should convert commitment from rhetoric into observable practice by protecting the quality function's authority to reject marginal batches irrespective of delivery pressure, as this single decision rule does more to signal commitment than any policy document. Most importantly, a structured operator competency programme should be established, covering the technical basis of preservation chemistry, control chart interpretation, and abnormality response, coupled with formal authority to halt cycles exhibiting parameter excursion and a suggestion system with visible response. Finally, a field performance feedback loop should be established linking pole failures in the network back to treatment batch records, closing the informational gap created by the deferred nature of quality failure in this industry.

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