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# Examining the Correlation of Critical Factors for Effective Quality Control Performance in TARURA Road Infrastructure Projects

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## ABSTRACT

This study examines the interrelationships among key determinants of quality control performance in road infrastructure projects implemented under the Tanzania Rural and Urban Roads Agency. The quantitative approach was adopted, and data analysed using the SPSS package was used together with the Principal Component Analysis (PCA) analysis test that produced four classified factors represented by the model path diagram: Human Resource Capacity (HRC), Procedural and Technical Compliance (PTC), Stakeholder Communication (SC), and Systemic Institutional Control (SIC) to facilitate effective quality control performance. The findings reveal a hierarchical correlation structure in which HRC emerges as the most influential construct. A strong positive correlation ($r = 0.69$) between HRC and SIC indicates that skilled personnel, training, and contractor competence are critical in facilitating adherence to technical standards and quality procedures. Similarly, PTC demonstrates a substantial and strong association with SC ($r=63$), suggesting that workforce capacity significantly enhances communication efficiency among project stakeholders. In contrast, SIC exhibits relatively weak correlations with other constructs ($r = 0.30–0.50$), indicating that while management commitment and enforcement mechanisms are relevant, they function primarily as enabling rather than driving factors. The results underscore that quality control performance is shaped by a system of interdependent variables rather than isolated interventions. The study concludes that strengthening HRC is the most reliable strategy for improving overall quality outcomes. However, persistent gaps in digital quality control tools and on-site expertise constrain performance. A combined approach involving capacity building, standardised communication protocols, and gradual technological integration is recommended to enhance infrastructure durability and optimise resource utilisation.

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## 1.0 Introduction

Industrialisation and urbanisation have created a severe need for sustainable and sociable transportation systems, leading to global recognition of road infrastructure networks as essential alternatives (Li *et al.,* 2025). The rising traffic volumes have made the current road networks encounter an increasing difficulty, necessitating an increased road construction project worldwide (Liu *et al.,* 2022). Road infrastructure has always acted as the backbone system of every urban spatial arrangement, serving not only as a means for people's mobility and urban logistics but also overwhelmingly promoting the economic vitality and sustainability of all cities. Road infrastructure predominantly enhances industrial agglomeration and regional competitiveness (Cheng *et al.,* 2025). Thus, the development of road networks has globally proved to reduce transportation expenses and commuting times, enhance enterprise logistics efficiency, and create conditions for the clustering of manufacturing, commerce, and logistics parks (Jue *et al.,* 2024).

Recently, sub-Saharan Africa (SSA) has observed a growth in road infrastructure development fuelled by multiple momentous investments in road and highway development (Muller-Mahn, 2020). The surge in road construction has marked significant progress in modernity and connectivity. The extension of road networks' connectivity has advocated a key step toward modernity, enabling trade and transport of goods, people, and services (Lisa *et al.,* 2025); enhancing tourism; providing access to amenities such as schools, hospitals, and markets; and thus leading to improved economic progress (Kalvelage *et al.,* 2021). Thus, it is clear that developing countries primarily rely on the construction industry for sustainable development, as this sector provides and directly influences socio-economic growth (Mwemezie *et al.,* 2023). Therefore, a lack of adequate infrastructure will inevitably hinder the growth of a country's other economic sectors, resulting in substandard living standards, uneven income distribution, and poverty, all of which ultimately contribute to the country's economic downfall.

Road infrastructure networks have for quite a long time constituted the mainstay of Tanzania's transportation system, accounting for nearly 80% of passenger traffic and 75% of freight movement within the country (Kamugisha *et al.,* 2024). Tanzania's road transport systems have rendered an essential network for national economic development. The road networks have become necessary for connectivity, economic activity, and social integration in a nation of over 61 million people, covering an area of 947,300 km² and distributed across urban centres, rural villages, and agricultural hinterlands (Mwemezi *et al.,* 2023).

Driven by its robust infrastructure network, Tanzania envisions itself as a model of resilience, innovation, prosperity, and diplomacy, both for Africa and globally (URT, 2025). Tanzania has noted having a progressive integrated road infrastructure to enhance its logistics capabilities and harmonise the movement of people, goods, services, and information throughout the supply chain network as a strategic and clear path to deliver a high-quality life for all Tanzanians. Moreover, it will be a main driver for socio-economic development, building an upper-middle-income country by 2050 (URT, 2025). Moreover, the observed momentous growth for construction projects, including the construction of roads, railways, bridges, water systems, telecommunications, and air transport networks, to mention a few, has verified a consistent yearly increase in government spending on infrastructure development in the past decade, which has motivated the continuous inflows of investments, including those from foreign investors (ITA, 2022).

Tanzania is trying to become a middle-income country with better roads that can support economic growth and better connectivity. In its TDV 2050 plan, Tanzania has identified integrated internal and regional logistics as a key component of construction projects that continuously facilitates and contributes to mitigating factors essential for becoming a regional trade hub (URT, 2025). Thus, investing in various megaconstruction projects—including the Standard Gauge Railway (SGR), the Julius Nyerere Hydropower Plant and Dam, and the construction of multiple commercial and residential buildings and bus terminals (Dickson *et al.*, 2025)—has provided a critical backbone for steady modernising economic growth. Furthermore, the expansion of rural roads under TARURA has contributed to improved productivity and enhanced international competitiveness (Kahyarara, 2022).

The Tanzania Rural and Urban Roads Agency (TARURA) was established under the President's Office – Regional Administration and Local Government and is mandated to develop, maintain, and manage the construction, rehabilitation, and maintenance of rural and urban roads across Tanzania with 184 councils. Since its inauguration, TARURA has succeeded in constructing and managing about 144,429.77 kilometres of roads, demonstrating a significant portion of Tanzania's total road network (Ahmad *et al.,* 2023). The roads under TARURA have served in facilitating agricultural product supply chains, intercommunity trade, and providing access to social services like healthcare and education. To support TARURA and acknowledge its significance, the Tanzanian government has consistently increased budgeted allocations for road development by 10% to 15% for construction projects, which has helped mitigate the national budget over the past ten years (NAOT, 2022). Despite its mandated roles, TARURA is confronted with inadequate funding and substandard road network conditions, with approximately 43% of the tertiary network deemed unsuitable for normal motor vehicle use during the rainy season (Gabriel *et al.,* 2025). Additionally, TARURA faces a shortage of staff, constraints in resource allocation, delays in completing construction projects that often compromise quality, supply-chain bottlenecks, and challenges related to the availability of quality standards (Willar*et al.,* 2023).

Despite Tanzania's struggle and investments to improve the performance of the construction industry in general and the quality of road construction projects in particular, it has constantly faced enormous obstacles, such as insufficient contractor capacity, poor material quality, a lack of skilled labour, and the use of antiquated technologies (Valence and Innocent, 2023). Moreover, fraud, inadequate quality control laboratories and personnel, lack of a regulatory framework, budget constraints, and absence of efficient building methods and supporting policies have continued to be disastrous (Kamugisha *et al.,* 2024). Furthermore, poor construction resulting from poor or inadequate quality control has compelled distinct attention from project participants (Arowolo *et al.,* 2019). The repetitiveness of early road deterioration represented by pothole realisation, shallow cracking, edge failure, and structural failure before the defect liability project period (DLP) ends has become progressively evident and has continued to undermine the TARURA project's quality performance outcomes (Dickson *et al.,* 2025). The situation has characterised a wastage of public resources, increased vehicle operating expenses and travel times, and undermined public confidence in government infrastructure programmes (Samuel *et al.,* 2021), emphasising the necessity for more studies on quality control in construction.

In his study on quality control in road construction, Chin *et al.* (2024) revealed multiple strategic factors for poor road quality control, comprising a poor workforce, poor material quality, poor management, limited budget allocation, inadequate design, and project time constraints (Chin *et al.,* 2024). The study documented prolonged misery despite the establishment of quality assurance, test plans, and the adoption of total quality supervision in construction projects. Furthermore, in their study findings to evaluate the features affecting construction project quality, Yohanes and Naruka (2023) cemented that to improve quality control, strategic factors including training for project leaders and stakeholders, observing codes and standards, planning and efficient management of personnel, excellent documentation, and setting quality objectives need to be considered (Yohanes & Naruka, 2023).

A study by Vadivel (2016) highlighted that quality control is an indispensable constituent of a construction project ever since all construction firms have been required by law to ensure the attainment of contractual and necessary quality products or services for the intended customer's needs. Vadivel (2016) recognised that quality control plays a key role in fulfilling client, stakeholder, and regulatory requirements.

Furthermore, a study by Tam *et al.* (2020) documented that prioritising effective quality control of the construction projects has continuously facilitated and contributed not only to mitigating the defects but also to increasing project quality performance (Oni et al., 2019).

This study therefore aims to examine the correlation of critical factors for effective quality control performance in TARURA Road infrastructure projects. The study aims to fill the gap since no previous study has modelled the correlational structure among quality control factors in TARURA projects using PCA.

Without embracing more efforts to address this gap, such as implementing stricter quality control measures, they will continue to hamper infrastructure and economic growth, especially in areas where quality control is undermined. Thus, this situation has necessitated the study to examine the correlation of critical factors for quality control performance in TARURA road infrastructure projects.

### *1.1 Theory Underpinning the Study*

#### *1.1.1 Total Quality Management Theory*

Total Quality Management (TQM) theory is a comprehensive, organisation-wide management theory focused on continuous improvement, customer satisfaction, and long-term success through the involvement of all necessary stakeholders. It focuses on improving processes to prevent defects, reduce waste, and foster a culture where every department works toward quality excellence. Bong *et al.* (2024) found that adopting relevant dimensions of TQM practices enhances project performance in construction projects, with process management, technology, leadership, and strategic planning as significant contributors. TQM combines basic management methods, current improvement projects, and technical tools in a structured way to improve the quality of products, processes, and services.

Alawag et al. (2024) noted that the Total Quality Management (TQM) theory continuously stresses that quality is the responsibility of every project employee or stakeholder for continuous improvement, which should be embedded in every organisational process (Alawag et al., 2024). The emphasis on four constructs identified, including Human Resource Capacity and Competence (HRC), Procedural and Technical Competence (PTC), Supervisory and Control (SC), and Stakeholders' Integration and Communication (SIC), directly reflects TQM's foundational pillars. HRC corresponds to TQM's emphasis on employee competence, training, and knowledge as drivers of quality performance, as the study found that shortage of skilled QC personnel and lack of regular training were among the top-ranked factors for inadequate quality control (Assagaf et al., 2025). Similarly, PTC aligns with TQM's principle that management decisions should rely on factual data generated through systematic monitoring, inspection, and adherence to standards, which was evidenced by non-adherence to technical specifications and failure to use digital QC reporting tools as contributing factors. SC reflects TQM's requirement for leadership commitment and effective oversight, demonstrated by ineffective contractor supervision and failure to impose strict penalties, while SIC embodies TQM's emphasis on customer satisfaction and stakeholder engagement through effective communication and timely sharing of non-conformance reports.

## 2.0 Materials and Methods

### *2.1 Study Area*

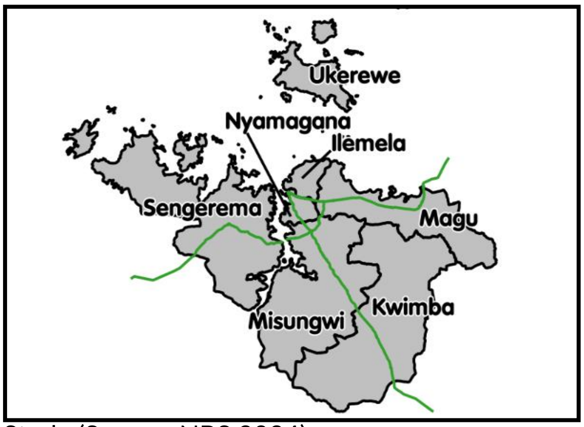
The research was carried out in the Mwanza region, located on the southern shores of Lake Victoria, in Tanzania. The region is characterised by predominantly rocky, hilly terrain and a complex network of islands and peninsulas. The Mwanza region contains seven districts, namely Nyamagana, Ilemela, Sengerema, Misungwi, Kwimba, Magu, and Ukerewe. Generally, the chosen case study inhabits high-traffic-volume classified road networks, including district, urban, and feeder roads. It also occupies a substantial share of budgets and experiences diverse geographical conditions, including swampy lakeshore areas and solid rock zones. Furthermore, it lies within a tropical climate with distinct wet and dry seasons, creating challenges for construction projects and emphasising the necessity of strong quality control to ensure the durability of infrastructure against climatic conditions.

*2.2 Research Design*

A quantitative method was employed in this study to collect survey data using a structured questionnaire designed to measure the critical factors and strategies.
strategies.

Figure 1

*Map of Mwanza District Boundaries as a Case*




Study (Source: NBS 2024)

*2.3 Population Sampling and Sampling Technique*

The study target population comprised clients, contractors, consultants, and regulators within eleven selected construction projects. The study considered a total population of one hundred eighty-seven (187) stakeholders involved in eleven TARURA road construction projects in the Mwanza region over two years, including ongoing projects. Using Taro Yamane's formula. A sample size of one hundred twenty-eight (128) was drawn using a purposive sampling technique to guarantee a proper representation across the key respondent categories who have enough experience and with exhaustive information about the construction projects.

The sample size was obtained using the following equation: $n = \frac{N}{1+N(e)^2}$

$$= \frac{187}{(1+187X0.05^2)} = 128$$

Where:

***n*** stands for the sample size.

***N*** stands for the total number of populations.

***e*** stands for margin of error.

*2.4 Data Collection Methods*

The study exploited two main approaches for data collection. Firstly, a literature review was done to ascertain the factors and strategies for construction quality control. Secondly, a structured questionnaire designed with a 5-point Likert scale was administered to the sampled population to assess their opinions on critical factors for construction quality control. However, every tool used underwent a pretest with twenty (20) experienced respondents to facilitate the review and ensure clarity and reliability. The results of the pretest facilitated the review process by identifying and reducing ambiguous terms and typos, as well as improving overall focus. Moreover, institutional approval, informed consent from respondents, and data confidentiality were all considered and upheld for ethical purposes.

*2.5 Data Analysis*

After data collection, entry, coding, and editing, a total of ninety-three (93) approximately 72.7% of well-attended questionnaires were identified and used for data analysis using Statistical Packages for Social Science (SPSS 26). Construct validity was assessed to determine whether all items on a scale measure the same construct, followed by internal reliability of the 5-point Likert scale, intended to verify whether the questionnaire yields consistent outcomes across tests (Taber, 2017). The analysis yielded a Cronbach's alpha of 0.791 for the critical factors. However, the computed Cronbach's alpha values were all within the recommended threshold of 0.7. Moreover, the Principal Component Analysis (PCA) was tested for Kaiser-Meyer-Olkin (KMO) to measure the sampling adequacy of the intended critical factors, making the Bartlett's test of sphericity approximate chi-square (2418.836) and KMO (0.878), suggesting the suitability of the samples for factor analysis (Samaraweera, 2020) at a significant level of 0.000 (Table 1). Generally, the findings have acknowledged a non-identical correlation matrix and thus are suitable for principal analysis.

Table 1

*Kaiser-Meyer-Olkin (KMO) and Bartlett's Test*

| | | |
|---|---|---|
| KMO Measure of Sampling Adequacy. | | 0.878 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 2418.836 |
| | df | 66 |
| | Sig. | 0.000 |

In addition, the SPSS software was applied to calculate the eigenvalues extracted from Principal Component Analysis (PCA), accounting for approximately 84.04% of the variance (Table 2). Nonetheless, the percentage of overall variance explained by a selection of principal components or factors has been expressed by the cumulative percentage of initial eigenvalues.

Table 2
*Initial Eigenvalues*

| Component | Total | % of Variance | Cumulative % |
|---|---|---|---|
| 1 | 7.199 | 59.994 | 59.994 |
| 2 | 2.271 | 10.595 | 70.589 |
| 3 | 1.988 | 8.231 | 78.821 |
| 4 | 1.626 | 5.216 | 84.037 |
| 5 | .763 | 3.856 | 87.893 |
| 6 | .347 | 2.891 | 90.784 |
| 7 | .290 | 2.419 | 93.203 |
| 8 | .243 | 2.022 | 95.225 |
| 9 | .181 | 1.510 | 96.735 |
| 10 | .167 | 1.394 | 98.129 |
| 11 | .131 | 1.092 | 99.221 |
| 12 | .093 | .779 | 100.000 |

Furthermore, Table 3 presents the equamax-rotated cluster matrix, in which each of the 12 critical factors is loaded exclusively onto one of the four components. A factor loading threshold value of 0.5 was adopted (Hair, 2019). Although the empirical justification for such cut-off values remains debatable, the primary objective of principal component analysis (PCA) is to reduce a set of items into well-defined components. Applying this criterion, the 12 critical factors aligned with the four theoretical constructs. For easy identification and interpretation, an intensive analysis and a systematic assessment of critical factors constituting a single particular cluster were performed that facilitated the critical factors' cluster naming. Thus, four generated clusters were, namely, Human Resource Capacity and Competence (HRC), Supervisory and Control (SC), Procedural and Technical Competence (PTC), and Stakeholders' Integration and Communication (SIC).

Table 3
*Component Matrix after Equamax Rotation*

| Critical Factor for Quality Control | Component | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Availability of Skilled Quality Control Personnel (HRC1) | 0.868 | 0.190 | 0.228 | 0.198 |
| Regular training on quality control to project stakeholders (HRC2) | 0.749 | 0.338 | 0.099 | 0.364 |
| Employing a competent & experienced contractor (HRC3) | 0.738 | 0.257 | 0.273 | 0.354 |
| Employ or hire the QC experts at the site (HRC4) | 0.604 | 0.519 | 0.337 | 0.137 |
| Effective contractor supervision by TARURA engineers (SC1) | 0.696 | 0.696 | 0.141 | 0.318 |
| Management commitment to quality (SC2) | 0.277 | 0.808 | 0.282 | 0.198 |
| Imposing strict penalties (SC3) | 0.509 | 0.709 | 0.186 | 0.269 |
| Timely corrective actions for defects (SC4) | 0.205 | 0.901 | 0.019 | 0.223 |
| Adherence to approved technical specifications & standards (PTC1) | 0.156 | 0.486 | 0.685 | 0.281 |
| Use of digital QC reporting tools or systems (PTC2) | -0.007 | 0.626 | 0.644 | 0.228 |
| Effective communication between project stakeholders (SIC1) | 0.124 | 0.140 | 0.212 | 0.886 |
| Timely sharing of quality inspection & non-conformity reports (SIC2) | 0.297 | 0.282 | 0.352 | 0.589 |

Additionally, Equations 1 and 2 were adopted to calculate the composite reliability (CR) and the average variance extracted (AVE) of different constructs as shown in Table 3 above, and their findings were found to be within the acceptable threshold values of 0.7 and 0.5, respectively. The findings (Table 4) below present and recommend the presence of a related convergent validity between the four construct variables.

$$\boldsymbol{CR} = \frac{\sum_{i=1}(\lambda i)^2}{\sum_{i=1}(\lambda i)^2 + (\sum_{i=1} \delta)} \text{ ......................} \textit{equation 1}$$

$$AVE = \frac{\sum_{i=1}(\lambda i)^2}{N} \text{..................... equation 2}$$

**Where:**
CR= construct reliability,
AVE = Average Variance Extracted,
i=represents the total number of items,
N =represents the number of indicators.
δ =represents the error variance term for each latent variable, and
Λ= represents factor loadings (standardized regression weights).

Table 4
*Constructs Convergent Validity Test Result*

| Convergent validity | *HRC* | *SC* | *PTC* | *SIC* |
|---|---|---|---|---|
| *AVE=∑xi2÷N Value>0.5* | 0.656 | 0.695 | 0.578 | 0.535 |
| *CR=∑(xi)2÷(∑(xi)2+∑δ) Value>0.7* | 0.791 | 0.824 | 0.739 | 0.771 |
| Comments | Established | Established | Established | Established |

## 3.0 Findings

### *3.1 Demographic Characteristics of the Respondents*

The study involved 128 respondents, with the majority being male (89.8%) and a smaller proportion female (10.2%). The results reveal a significant under-representation of women in road construction projects. Sospeter and Rwelamila (2020) found that the construction industry in Tanzania faces significant gender disparity, with women being under-represented due to various factors, including cultural backgrounds, social structures, and lack of confidence. Most respondents had significant experience implementing road construction projects, with 40.8% having 9–12 years of experience and 28.4% having thirteen years or more. Respondents with 1-4 years of experience accounted for 10.8%, while those with 5-8 years of experience accounted for 20.0%. A combined 69.2% of respondents have over a decade of practical experience in public construction projects. The large representation of experienced professionals supports the credibility and reliability of the findings. Respondents aged between 35 and 44 years constituted the majority, accounting for approximately 56.8%. Respondents aged 19-24 and 25-34 accounted for 10.6% and 25.4%, respectively. The lower representation of individuals aged 19–24 in road construction projects can be linked to several factors, such as the fact that many young adults are still pursuing education or lacking the practical experience required for the work. Respondents aged 45 years and above accounted for 7.2% of all respondents.

### *3.2 Ranking of Critical Factors*

The Statistical Package for the Social Sciences (SPSS 26) was used to compute the descriptive information of critical factors (manifested from the literature review) generated in descending mean scores and t-values (Table 5). The binary Likert scale number (from 1=very high importance to 5=very low importance) is anticipated to designate the numerical ranks only. However, a continuous average rating of the ordinal values defined as 1 to ≤ 1.8 to represent very low importance, 1.81 to ≤ 2.6 to represent low importance, 2.61 to ≤ 3.4 to represent neutral, 3.41 to ≤ 4.2 to represent high importance, and 4.21 ≤ 5 to represent very high importance was adopted to assist in translating precisely the findings of the respondent. Since this study adopted a 5-point Likert scale, only critical factors ranked equal to or above the scale value of 3.41 (implying high importance) were highlighted and prioritised to facilitate improvements in quality control performance (Al-Emran *et al.,* 2021). Nevertheless, whenever two or more critical factors fall within the same mean scale value, the one with a high t-value(s) is selected the most. Table five (5) below clearly reveals the ranked findings of critical factors for quality control (QC) in road construction projects under the Tanzania Rural and Urban Roads Agency. The factors have been listed in descending order of their mean scores and t-values, demonstrating the perceived importance of each factor to the respondents.

The top five critical factors, all of which have scored a mean rating higher than 4.0 on a 5-point Likert scale, are led by availability of skilled quality control personnel, which ranks highest

(4.52, SD = 0.68, t = 12.56), followed closely by regular training on quality control for project stakeholders (mean = 4.48, SD = 0.72, t = 11.97), effective contractor supervision by TARURA engineers or consultants (mean = 4.41, SD = 0.75, t = 11.43), employing competent and experienced contractors (mean = 4.38, SD = 0.80, t = 10.76), and timely corrective actions for defects (mean = 4.29, SD = 0.84, t = 10.41). The high mean scores, shared with large t-values (ranging from 10.41 to 12.56) at 95% confidence intervals that lie completely above 4.0, designate a strong and statistically significant agreement among respondents on the critical importance of the factors needed to improve quality control in road construction projects. However, the relatively low standard deviations (0.68–0.84) suggest that respondents' opinions were consistent for these top factors.

Table 5
*Ranking of Critical Factors for Quality Control Performance Improvement*

| Critical Factor for Quality Control | Mean | SD | T-value* | 95% CI Lower Bound | 95% CI Upper Bound |
|---|---|---|---|---|---|
| Availability of Skilled Quality Control personnel | 4.52 | 0.68 | 12.56 | 4.40 | 4.64 |
| Regular training on quality control to project stakeholders | 4.48 | 0.72 | 11.97 | 4.35 | 4.61 |
| Effective contractor supervision by TARURA engineers or consultant | 4.41 | 0.75 | 11.43 | 4.27 | 4.55 |
| Employing competent & experienced contractor | 4.38 | 0.80 | 10.76 | 4.24 | 4.52 |
| Timely corrective actions for defects | 4.29 | 0.84 | 10.41 | 4.14 | 4.44 |
| Management commitment to quality | 3.85 | 0.92 | 7.67 | 3.68 | 4.02 |
| Imposing strictly penalties | 3.79 | 0.96 | 7.21 | 3.62 | 3.96 |
| Effective communication between project stakeholders | 3.52 | 1.04 | 5.87 | 3.33 | 3.71 |
| Timely QC inspection report sharing & non-conformance records | 3.15 | 1.09 | 4.49 | 2.96 | 3.43 |
| Adherence to approved technical specifications & standards | 3.48 | 1.07 | 5.63 | 3.29 | 3.67 |
| Employ or hire the QC experts at site | 2.94 | 1.12 | 2.89** | 2.74 | 3.14 |
| Use of digital QC reporting tools or systems | 2.62 | 1.18 | 2.01** | 2.41 | 2.96 |

The following next five factors scored mean values between 3.0 and 4.0: management commitment to quality (mean = 3.85, SD = 0.92, t=7.67), imposing strict penalties (Mean = 3.79, SD = 0.96, t=7.21), effective communication between project stakeholders (Mean = 3.52, SD = 1.04, t=5.87), adherence to approved technical specifications and standards (Mean = 3.48, SD = 1.07, t=5.63) and timely QC inspection report sharing & non-conformance records (Mean = 3.15, SD = 1.09, t = 4.49) have been perceived as moderately important with less consensus. Nonetheless, their t-values (4.49–7.67) have remained above the acceptable significance threshold value of ±1.96. Conversely, the higher standard deviations (0.92–1.07) have acknowledged a greater variability in respondents' opinions, suggesting less agreement on the importance of the four factors compared to the top five.

The last two factors earned mean scores below 3.0 and indicated disagreement by the respondents to be included in the list of critical factors for quality control despite their t-values (2.89 and 2.01, respectively) being above 1.96, making them statistically significant but with their mean scores below the neutral threshold. Thus, employing or hiring the quality control experts at the site (mean = 2.94, SD = 1.12, t=2.89) and using digital quality control reporting tools or systems (mean = 2.62, SD = 1.18, t=2.01) were ranked the lowest. The varied standard deviations (e.g., 2.41–2.96 for digital tools) have reflected a substantial disagreement among respondents, with some possibly acknowledging these factors as important while most do not. Remarkably, the use of digital QC reporting tools or systems was perceived as the least overall critical factor.

Generally, the findings from the data indicate that respondents have considered human and managerial variables the most important drivers of quality control, with less consideration given to resource and technological elements.

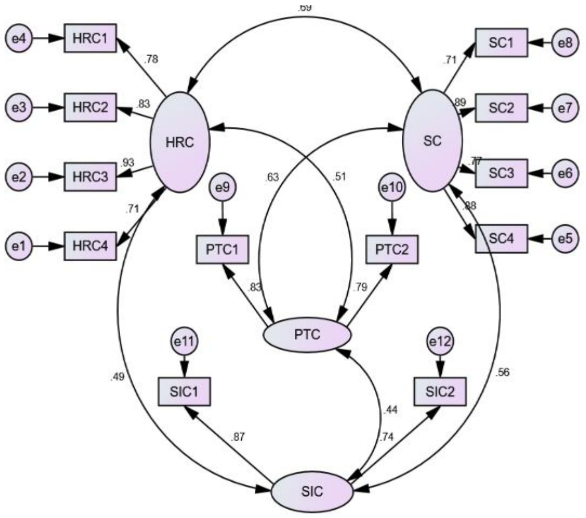
### *3.3 Correlation of Critical Factors*

In any construction environment, quality control performance is consistently impacted by various interconnected factors rather than occurring in isolation. Determining the correlation between critical factors has become crucial for TARURA road infrastructure projects, which work under particular challenges of remote site locations, restricted laboratory access, and tight budgetary constraints. A correlational approach leads to the assumption that changes in one critical factor are statistically related to changes in others, jointly influencing QC success or failure. Thus, mapping the correlation to determine which factor pairs produce the strongest positive or negative correlation with QC metrics offers a logical foundation for setting priorities for the distribution of resources and process enhancements, making TARURA lengthen project life cycles.

Figure 2 below provides the variable labels of four distinct latent constructs clearly generated by SPSS-AMOS and aligned with the clusters described previously (Table 3) derived from the descriptive statistics.

Figure 2

*A Model Path Diagram Showing the Correlation of Critical Factors.*




Source: Researchers (2026)

*3.3.1 Correlation between HRC and PTC*

The model places the constructs Procedural & Technical Compliance (PTC) and Human Resource Capacity (HRC) as separate but closely linked latent variables. PTC is measured by two distinct indications (PTC1–PTC2), while HRC is measured by four indicators (HRC1–HRC4). The model suggests that there is a high positive correlation between the two constructs (51%), as adhering to technical requirements, utilising digital tools, and carrying out corrective actions (PTC) are all logically preceded by skilled individuals, training, and competent contractors (HRC).

*3.3.2 Correlation between HRC and SC*

The most direct, strong and positive correlation between the two latent constructs is noted within the structural model estimated at 69%. The correlation is based on the fact that human resource capability, such as having qualified QC staff, frequent training, capable contractors, and on-site QC specialists, makes it possible for stakeholders to communicate effectively. Competent staff members are better able to communicate quality standards, effectively report non-conformances, and have fruitful conversations with TARURA engineers, contractors, and consultants. Frequent training guarantees that all parties adopt uniform reporting formats and strengthens communication norms. Skilled contractors are more likely to ask for clarification on requirements and share inspection results in a proactive manner. The findings justify that as HRC improves, SC should improve correspondingly.

*3.3.3 Correlation between HRC and SIC, and between PTC and SIC*

The findings suggest a weak-to-moderate association (about 49%) between HRC and SIC. This is because HRC focuses on the availability and competency of on-site employees, whereas management commitment and penalty enforcement (SIC) operate at the organisational policy level. Although they are not closely related, these two areas indirectly affect one another—for instance, dedicated management allocates funds for training. Similarly, the separation of indicators shows that PTC also depends on factors beyond top-down enforcement, such as individual worker diligence and tool availability. Institutional control can enforce procedural compliance through oversight and fines.

*3.3.4 Correlation between PTC and SC, and between SC and SIC*

The findings indicate a relatively strong correlation (between 0.50 and 0.70) between PTC and SC. Thus, stakeholders must communicate to follow technical procedures, including reporting test findings, recording non-conformances, and implementing corrective measures. Of the four construct pairs, the correlation between SC and SIC is the weakest, ranging from 0.30 to 0.50. It is noted that although communication standards can be mandated by management commitment and sanctions (SIC), top-down institutional control does not consistently result in high-quality communication across TARURA projects due to the considerable variability inherent in SC. The model generally suggests a hierarchical correlation structure, with SIC exhibiting only weak correlations with all other variables, and HRC–PTC showing the strongest correlation, followed by PTC–SC, then HRC–SC.

## 4.0 Discussion

The study on factors for quality control performance in road infrastructure projects under the Tanzania Rural and Urban Roads Agency (TARURA) has identified twelve factors contributing to poor quality control performance in TARURA road construction projects classified in four major clusters, namely Human Resource Capacity and Competence (HRC), Supervisory and Control (SC), Procedural and Technical Competence (PTC), and Stakeholders' Integration and Communication (SIC). Overall, almost all cluster factors were mentioned by TQM theory as an important element in quality improvement.

The findings clearly show that interconnected organisational and operational imperfections that compromise project outcomes are more likely to be the cause of quality failures than isolated instances. Jointly, the above factors have created an environment that fosters an atmosphere that compromises quality control, thus leading to inadequate quality (substandard) road infrastructure.

The findings of this study reconcile those of Juma & Nsimbila (2025) and Juma (2025), who collectively provided the robust and empirical evidence that supports the study's conclusion that interconnected organisational and operational weaknesses, rather than isolated incidents, are the primary drivers of poor quality control in TARURA's road projects.

This study aimed to investigate the association of essential factors with successful quality control performance in road infrastructure projects under the Tanzania Rural and Urban Roads Agency (TARURA). The study identified twelve critical factors. A hierarchical correlation structure among the four components was shown by the correlational analysis using a model path diagram. HRC and PTC showed the strongest positive association (estimated r = 0.65–0.80), indicating that training and qualified staff directly facilitate procedural compliance. Additionally, a substantial association (r = 0.55–0.75) between HRC and SC was discovered, suggesting that worker capacity is a reliable means of enhancing stakeholder communication. Moderate associations were observed between PTC and SC (r = 0.50–0.70) as well as between PTC and SIC (r = 0.45–0.60). SIC (Institutional Control) had the smallest correlations with other variables, especially with SC (r = 0.30–0.50), indicating that management commitment and the execution of penalties serve as enabling but non-dominant correlates of quality control performance.

The study concludes that a correlated system of four interdependent constructs, rather than a single factor, drives successful quality control performance in TARURA road infrastructure projects. The most powerful and dependable lever is human resource capacity (HRC), which correlates strongly with stakeholder communication and procedural compliance. Institutional control (SIC) is statistically significant, but it plays a supporting role rather than a central one. The consistently low rankings and weak integration of digital reporting tools and on-site QC experts point to a critical technological and resource gap that TARURA must address. To strengthen the weaker constructs, the study suggests that TARURA prioritises investments in workforce capacity (training, skilled personnel, and competent contractors) as the primary intervention point, while concurrently standardising communication protocols and progressively introducing digital QC tools. Failure to address these correlated factors holistically will perpetuate the cycle of premature road deterioration, waste of public resources, and diminished stakeholder confidence in Tanzania's Rural and Urban Road-Mwanza infrastructure. To confirm the association paths suggested by the correlational model, further research should include longitudinal data and broaden the geographic scope outside the Mwanza region.

The study limitation encompasses a cross-sectional research design, collecting data from ongoing and recently completed projects at the Mwanza region only. However, the findings are therefore confined exclusively to the Mwanza region of Tanzania and can be generalised to only areas having the same environment as those of the TARURA projects in Mwanza, Tanzania.

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