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Quality Control and Performance of Road Construction Projects in Nyamira County, Kenya

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ABSTRACT

Purpose: The study aimed at finding the relationship between quality control practices and the performance of any road construction project that the County government of Nyamira, Kenya, has implemented from 2019 to 2024.

Methodology: The methodology used was mixed methods that involved quantitative and qualitative data, for the purposes of providing a comprehensive understanding of the relationship between the variables of the study. The community representatives were interviewed using semi-structured interviews to gain a detailed perspective on the practices of quality control and how it is implemented in public road works. Firstly, quantitative data analysis and then qualitative data analysis. The results of both strands were then analyzed together at the interpretation phase in order to promote triangulation, interpretation of the quantitative results and a fuller understanding of the research theme.

Unique Contribution to Theory, Practice and Policy: The study contributes to theory by studying and analyzing the effect of quality control within a devolved and resource constrained county setting, and by interpreting the results of the study within Total Quality Management, the Quality Trilogy, Project Management and Risk Management and Stakeholder theories. The County Engineers and Contractors should institute documented inspection and testing procedures, non-conformance registers, time bound defect rectification and hold point approvals for practice. The County Government of Nyamira should provide the resources for materials testing and supervision capacity and require quality control records as a precondition for certification of payment and acceptance of completed works.

Keywords: *Quality Control, Road Construction Projects, Project Performance, Materials Testing, Site Inspection, Defect Rectification, Nyamira County*

JEL Codes: *L74*



INTRODUCTION

Roads are one of the costliest and socially critical public goods. They link communities to markets, schools and health services, reduce the cost of transportation, and support community economic activities. As a road consists of many layers of earthworks, aggregates, structures for drainage and surfacing, the service life is therefore greatly influenced by the compliance of each layer and material to the design and specification during construction. Quality control is the operational process of inspection, testing, measurement and correction to ensure that work products meet specified requirements (Juran & Godfrey, 1999). If it's weak, defects will go undetected and will be added as later layers, will show up as rework, early degradation, and expensive maintenance.

The cost of defects and rework has been well known in the construction industry for years. Love and Li (2000) quantified the causes and costs of rework in two construction projects, and suggested that the implementation of quality management practices and enhancement of coordination of project documents would help to minimize rework. A similar analysis was conducted by Josephson and Hammarlund (1999) for seven building projects to identify causes of defects and their costs. These studies all point to the fact that poor performance is not a theoretical issue, it translates to more expenses and delays. Therefore, quality management in construction has shifted from end-of-line inspection to whole-of-process quality management like Total Quality Management (Arditi & Gunaydin, 1997), but its implementation on construction sites still has practical obstacles (Haupt & Whiteman, 2004) and inconsistent project control practices (Olawale & Sun, 2015).

In Africa, there is a persistent divide between what is recognised as important in ensuring the quality of both road and building construction and what is actually done. Nyakala et al. (2019) conducted a survey of 160 road-building practitioners at small and medium-sized road building companies in Limpopo Province, South Africa, to find out about the importance of the 35 quality assurance practices implemented in road construction activities; quality control of construction work through supervision, monitoring, inspections and evaluations received the highest importance rating (mean 4.96 on a five-point scale); only 13 of the 35 practices were rated as excellently implemented; and training-related practices were among the weakest. In Tanzania, Rubaratuka (2018) observed the construction sites related to the reinforced concrete buildings in Dar es Salaam, and concluded that quality control practice was not well implemented in most of the construction sites. The evidence available is from varying sub-sectors and countries, but the findings are the same: quality control is seen as good in all and valued in many, but not always applied, where supervisory and testing capacity are limited.

The institutional structure in the road sector in Kenya is multi-layered. The Kenya Roads Board and the three road agencies, the Kenya National Highways Authority (KeNHA), the Kenya Urban Roads Authority (KURA) and the Kenya Rural Roads Authority (KeRRA) were established by the Kenya Roads Act of 2007 (Republic of Kenya, 2007). According to the Constitution of Kenya, 2010, the county administration is responsible for county transport which comprises County roads

(Republic of Kenya, 2010). Counties, therefore, plan, procure, supervise and inspect road works themselves, sometimes with few engineering staff, testing facilities, and funds. Quality management practices have been studied in Wajir County (Mohamed, 2023), total quality management in KeRRA projects in Kirinyaga County (Mwangi, 2023), project planning and project management practices in Nairobi City County (Mwangi, 2023; Nyakundi & Wanjiru, 2025) and project control systems in rural roads (Obare et al., 2016). Mohamed (2023) noted that most of the road projects in the county governments in Kenya do not reach their completion period, a high percentage of them complete late and some of them fail to complete at all.

These are national concerns that are evident in Nyamira County. The Star report for the financial year ended 30 June 2023 indicates that stalled, delayed and idle projects, which comprise roads, were identified in ten counties, including Nyamira, by Auditor-General (AG) reports. Roads delivered to residents and oversight bodies are becoming more expected to be delivered in a timely manner, budget and standard that lasts. It remains to be proved that the County's Day to day quality assurance practices (site inspection, materials testing, workmanship monitoring, adherence to technical standards and defect rectification) are correlated with improved project outcomes. The aim of this study is to answer that question; what is the relationship between quality control practices and the performance of road construction projects implemented by the County Government of Nyamira, Kenya?

Statement of the Problem.

Road construction projects expected to come to Nyamira County will produce a long-lasting and functional road within the stipulated time and budget as well as technical specifications. In reality, most county roads are delayed and some projects in Nyamira County have stalled (The Star, 2024) and are reported as stalled or delayed in Auditor-General reports to the Parliament for 2022/2023 financial year (Mohamed, 2023). Non-conforming work is hidden by overlying work layers and will be recognized later as rework or premature failure and increased maintenance expenses (Love & Li, 2000; Josephson & Hammarlund, 1999). Existing evidence indicates that quality control is perceived as being significant but not always practiced (Nyakala et al., 2019; Rubaratuka, 2018).

Previous Kenyan research on the performance of road projects has mostly focused on a general package of project management or quality management practices in Nairobi, Wajir and Kirinyaga (Mohamed, 2023, Mongina & Moronge, 2021, Mwangi, 2023, Nyakundi & Wanjiru, 2025). In these studies, quality control is either one of a large number of items or is dealt with by one proxy like inspection. Only limited evidence exist at the county level that separates out quality control, measures it for the major components of the system (namely inspection, testing, workmanship monitoring, compliance and defect rectification), and estimates its relationship with project performance while controlling for all other quality management processes. This fact does not allow the County Government of Nyamira to assess the priority it should allocate to the capacity for

quality control as compared to other investments. This study thus investigated the relationship between quality control and performance of road construction projects in Nyamira County.

Objective, Research Question and Hypothesis

The objective of the study was to examine the relationship between quality control and the performance of road construction projects implemented in Nyamira County between 2019 and 2024. The study was guided by the research question: What is the relationship between quality control and the performance of road construction projects implemented in Nyamira County between 2019 and 2024? The following null hypothesis was tested at the 5% level of significance:

H₀: Quality control has no statistically significant relationship with the performance of road construction projects in Nyamira County.

LITERATURE REVIEW

Theoretical Framework

Five complementary frameworks were used to anchor the study, these being Total Quality Management Theory, the Quality Trilogy and statistical quality control, Project Management Theory, Risk Management Theory and Stakeholder Theory. The first four provide reasons for and how quality control should impact project results, while the fifth provides an explanation of why other practices were considered control variables and why community perception is relevant in determining the results.

Total Quality Management (TQM) Theory. TQM can be traced to W. Edwards Deming (1986) who said that quality should be designed into the processes and continually improved and not relied upon by the finished product inspection. One of his rules was to eliminate mass inspection by "designing out" quality. The core ideas of TQM are customer focus, continuous improvement, involvement of everyone in the process and decisions based on data. Applied to road construction this means that inspection and testing should not be done at the 'handover' just once, but at every stage of the construction process, with deviations from specification picked up as they happen and the information used to correct the process. Several attempts have been made to apply TQM to the construction process, for example by Arditi and Gunaydin (1997) who studied the use of TQM in the construction process, and by Haupt and Whiteman (2004) who investigated the barriers to implementing TQM on construction sites. One of the recognized drawbacks of TQM is the requirement for training, supervisory skills and organizational commitment, which might not be available in resource-limited public organizations. In this study, the rationale for expecting that the systematic inspection, testing and corrective action was associated with better road project performance was TQM.

The Quality Trilogy, Statistical Quality Control. Shewhart (1931) developed the statistical control of quality by separating ordinary variation, which is a part of the normal operation of a

process, from problem-signal variation. Later, Juran (1986) stated that quality management is a trilogy of quality planning, quality control and quality improvement. In this framework, control consists of evaluating actual performance, comparing it with the quality goal and acting on the difference (Juran & Godfrey, 1999). This is the closest theoretical description of the quality control variable of this study: site inspections and materials tests provide evidence of actual performance; the specifications are the goal; the defect rectification is the action on the difference. The downside is that it assumes standards are unambiguous and measurement equipment is reliable, and if it's not, the control loop cannot function as intended if the laboratory is far away, equipment is missing or records are not maintained.

Project Management Theory. Project management as defined by Project Management Institute, 2021; and Kerzner, 2017, is the application of knowledge, tools and techniques for the purpose of planning, executing, monitoring and closing a project within constraints of scope, time and cost. The initiation and control of monitoring and controlling are part of the project life cycle and quality is regarded as a key aspect of project success beside time and cost (Chan & Chan, 2004). The theory therefore helped to inform the selection of the project performance indicators for the study which coped time, cost, specification compliance, durability and satisfaction. There is a snag, however, that formal tools can be applied rigidly or may be cost-prohibitive for smaller public bodies, and thus may not be effective on the ground if they are present on paper.

Risk Management Theory. The focus of risk management is the recognition, estimation, and mitigation of events that are uncertain, the impact of which is known, and the likelihood of their occurrence (Bernstein, 1996). Non-conforming materials, poor compaction, inadequate drainage and unrecorded design deviations are quality risks that can be addressed as events whose outcomes are escalating the longer they are not identified. Quality control may thus be viewed as a risk detection and risk containment process. This view has its drawbacks in that it relies on timely and accurate data; this is a common challenge in county contexts.

Stakeholder Theory. Freeman (1984) believed that all groups affected by or affecting an organization should be taken into account. Road users, residents, contractors, consultants and county officials all have expectations of quality and impact the implementation (Olander & Landin, 2005). Project scholarship is also a persistent theme in the involvement of stakeholders (Aaltonen et al., 2024; Agyemang et al., 2025). The stakeholder theory justified the use of an interview with the community to understand the perception of road quality after construction, and the inclusion of stakeholder involvement as a control variable in order to measure the impact of road quality control without any confounding from consultation and communication.

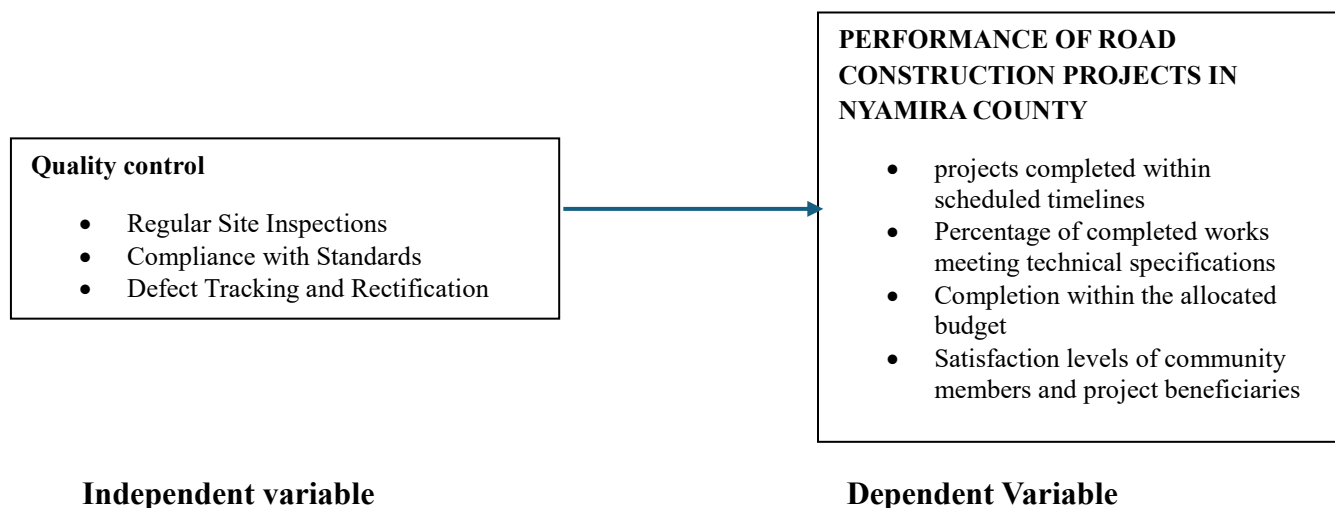
The five frameworks indicate that, overall, quality control should be positively related to project performance, the relationship should go through the stages of detecting and correcting non-conformance, and that the relationship should not be explained away by planning, contractor

capability and stakeholder engagement. These expectations were transformed into the conceptual framework and hypothesis of the study.

Conceptual Framework

The conceptual framework (Figure1) depicts the hypothetical relationship between the independent and the dependent variables. Project performance is the dependent variable and quality control is the independent variable. The premise of the framework is that quality control practices have a positive impact on project performance.

Figure 1: Conceptual Framework



Independent variable

Source: Author (2026)

Quality control refers to systematic activities ensuring that construction works and materials conform to approved designs and specifications. These activities include site inspection, materials testing, workmanship monitoring, compliance monitoring, and defect identification and rectification. Quality control differs from quality assurance: the former involves direct assessment of work produced, while the latter concerns the systems and processes ensuring requirements are met (Hughes, 2020).

Project performance refers to how well a project's planned outputs are delivered within defined boundaries. Cost performance remains a key indicator of infrastructure project success (Chan & Chan, 2004), while classical measures include time, cost, and quality (Flyvbjerg, 2014). For roads, additional indicators such as durability, corrective maintenance, accessibility, and beneficiary satisfaction are relevant, as road value is realized through use rather than handover.

Empirical Review

Quality control and project outcomes: international and regional evidence. Research on quality of construction has always demonstrated that quality failures represent unnecessary

expenses. Love and Li (2000) have quantified the causes and costs of rework in two projects, one under an FPS, and the other under an IPD contract, and found that the main cause of rework is due to client and end-user changes and that errors and omissions in the contract documentation is the second largest cause. They concluded that if construction firms and consultants are to reduce rework, they need to pay more attention to coordinating project documentation and implementing quality management practices. Josephson and Hammarlund (1999) analyzed the causes and costs of defects in seven building projects, and these results added weight to the argument that defects are high and significant costs that can be traced. The management systems level, Arditi and Gunaydin (1997) discussed the application of TQM throughout the construction process, Haupt and Whiteman (2004), discussed the barriers to using TQM in construction, and Olawale and Sun (2015) reviewed project control practice challenges and improvement recommendations in the UK. The contributions that make up this conceptual nexus between control, defects and cost were primarily from projects in high-income environments.

Nyakala et al. (2019) polled 160 road building practitioners belonging to small and medium-sized road building firms in Limpopo Province in South Africa. The quality control of construction work through supervision, monitoring, inspections and evaluations was the most important of 35 quality assurance practices rated (mean 4.96), whereas only 13 practices were rated as excellently implemented; and up-to-date training and management commitment to quality assurance (QA/QC training) were among the least important (mean of 3.5). In the city of Dar es Salaam, reinforced concrete building sites were studied by Rubaratuka (2018) who found that quality control was in most cases not adequately performed. Both studies indicate the need for an implementation gap, in which quality control is recognized as being important but is limited by capacity. Neither of these, however, are descriptive in emphasis and neither attempts to estimate the association between quality control and project performance.

Results from Kenyan road projects. There are several studies conducted in Kenya that link quality management or project management to the performance of the road projects. A number of studies have been carried out in Kenya to relate quality management or project management to road project performance. Mohamed (2023) assessed the quality management practices among the performance of road infrastructure projects in Wajir County with a sample of 108 staff members of the Wajir County sampled by stratified random sampling technique. Inspection had a positive and significant effect on performance ($\beta = 0.408$, $t = 3.597$, $p = 0.001$), as did quality auditing ($\beta = 0.431$, $p = 0.002$) and continuous improvement ($\beta = 0.406$, $p = 0.006$), whereas quality training was positive but not significant ($\beta = 0.176$, $p = 0.248$). The study suggested to use cube testing for the verification of road quality. In Kirinyaga County, Mwangi (2023) studied the relationship between TQM practices and the effectiveness of the road projects undertaken by Kenya Rural Roads Authority (KRRRA) between 2016 and 2020 on 70 road projects, finding that the overall TQM approaches had significant effects on the effectiveness of the road projects. In Nairobi City County, Mongina and Moronge (2021) reported that project management practices accounted for

approximately 77% of the variance in road project performance; Nyakundi and Wanjiru (2025) reported that the factors of budget planning, schedule planning, risk planning and communication planning were all significant positive predictors and together explained 68.7% of the variance in the performance of 21 road projects in the study which involved 63 project professionals. Obare et al. (2016) in their research looked at how project control systems are implemented and the performance of rural road construction projects in Kenya with the team experience diversity. The literature reviewed in Kenya all supports the direction of the relationship between quality related practices and road project performance.

Critique of the literature and/or a research gap.

The studies reviewed have three limitations. First, quality control is not in isolation. In the Kenyan studies it is either one part of a comprehensive package of practices (Mwangi, 2023; Nyakundi & Wanjiru, 2025) or a single proxy, inspection (Mongina & Moronge, 2021; Mohamed, 2023). Because of this, the one-to-one connection between quality assurance / quality control and performance, beyond planning, contractor capability and stakeholder involvement, is not well developed for county roads. Second, most of the evidence with regard to practice of quality control is from building projects or from other countries (Josephson & Hammarlund, 1999; Love & Li, 2000; Rubaratuka, 2018); the South African road study is descriptive and sets its focus on quality assurance (Nyakala et al., 2019). Third, the Kenyan road studies are based on the perceptions of the staff of the implementing agency and limited triangulation with the perception of the communities using the road.

The present study addresses these gaps by (i) isolating quality control and measuring it through five operational components; (ii) estimating its association with project performance with and without controls for quality planning, contractor competence and stakeholder involvement; (iii) focusing on a devolved county, Nyamira, where road projects are delivered under capacity constraints; and (iv) triangulating the survey results with interviews of community representatives.

METHODOLOGY

Research Design

The design used was correlational research design. The targeted population included 270 stakeholders involved in, responsible for or impacted by county road construction projects. A proportionately stratified random sample of 161 respondents was taken using Yamane's formula. Of these, 126 technical and administrative stakeholders were given structured questionnaires, and 35 community representatives were interviewed on a semi-structured guide. The overall response rate was 94.4%; with 120 questionnaires completed (95.2%) and 32 interviews completed (91.4%). The quality control scale was found to have a pilot-test Cronbach's alpha of 0.903. The data were subjected to SPSS version 27 analysis techniques which included descriptive statistics, Pearson

correlation and hierarchical multiple regression with quality control sub variables as control variables. Thematic analysis of interview data was used.

Target Population, Sampling Frame and Sample

The target population included 270 stakeholders directly involved in, responsible for or affected by road construction projects undertaken by the County Government of Nyamira during the projects' period of development (2019-2024). The sampling frame was created from the records of the Nyamira County Department of Transport, Roads, Public Works and Disaster Management and restricted to those who had been involved in or had firsthand knowledge of road projects conducted by the county during the study period. The sample size was calculated based on Yamane's (1967) formula for finite population:

$$n = N / [1 + N(e)^2] = 270 / [1 + 270(0.05)^2] = 270 / 1.675 = 161.19 \approx 161$$

Here, the sample size is denoted by n , the target population size is denoted by N and the margin of error, $e = 0.05$. The sample was proportionately drawn from six strata (Table 1) and respondents were randomly drawn within the strata. Structured questionnaires were used with the first five strata which included 126 technical and administrative stakeholders while interviews were conducted with 35 community representatives.

Table 1: Target Population and Sample by Stakeholder Category

Stakeholder category	Target population	Sample	Instrument
County Roads and Infrastructure Committee	20	12	Questionnaire
Contractors and subcontractors	120	72	Questionnaire
Project managers and engineers	20	12	Questionnaire
Quality assurance/control officers	35	21	Questionnaire
Procurement officers	15	9	Questionnaire
Community representatives	60	35	Interview guide
Total	270	161	

Source: (Author 2026)

Data Collection Instruments

The instruments used were a structured questionnaire and semi-structured interview guide. The questionnaire consisted of demographic, screening questions and five multi-item scales on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Quality control was evaluated by questions during regular site visits, checking the quality of construction materials before installation, checking the workmanship, meeting technical specifications and standards and identifying and correcting defects. The following items were used to evaluate project performance:

timely completion, cost of project, technical requirements, quality, durability, and serviceability and stakeholders' satisfaction. The following information was gathered in a semi-structured interview guide: community involvement, community views on the quality and durability of roads, project delays, satisfaction with result and suggestions for improvement. It was given to community representatives and the data from the survey were analysed thematically as a triangulation of the survey.

Pilot study reliability and validity.

The instruments were pre-tested in Kisii County. The pilot was based on 16 participants, which is about 10% of the sample, 12 were technical and administrative stakeholders who completed the questionnaire and 4 were community stakeholders who tested the interview guide. In this study, pilot participants were not included in the main study. The internal consistency of the scales was determined by Cronbach's (1951) alpha coefficient with a minimum of 0.70 accepted (Nunnally & Bernstein, 1994). All scales had good internal consistency, with α values ranging from 0.864 (project performance) to 0.903 (quality control). All scales demonstrated acceptable internal consistency, with values ranging from 0.864 (stakeholder involvement) to 0.903 (quality control). The instruments were face and content validated with the study objective, conceptual framework and literature with the research supervisors and by revising the items that the pilot respondents found unclear. Construct-related validity was addressed by making sure that each item corresponds to the operational indicators of its construct.

Data Collection Procedure

The researcher was introduced to JKUAT, County authorities gave access to the respondents and departmental records and the researcher had a research permit from the National Commission for Science, Technology and Innovation (NACOSTI) prior to data collection. Eligibility screening of Respondents was performed. The questionnaires were sent to the respondents in both paper and electronic formats, depending on their accessibility, and were followed up for better response. Interviewees agreed to the recording and transcribing of their interviews. The participation was voluntary and answers confidential.

Data Analysis and Diagnostic Tests.

The data collected from the questionnaire was coded, cleaned and analyzed using SPSS version 27. Data were summarized in terms of frequencies, percentages, means and standard deviations. Strength and direction of association was measured with Pearson's correlation coefficient which was interpreted as association and not causation. Hierarchical multiple regression was used to estimate the contributions of quality control, quality planning and contractor competence and stakeholder involvement to project performance. In addition, a simple regression of performance as a function of quality control was estimated. The significance level used was 5%. The coefficient

for quality control in the final model is associated with quality control while controlling for the other three practices. The final model was given as:

$$Y = \beta_0 + \beta_1 QC + \beta_2 QP + \beta_3 CC + \beta_4 SI + \varepsilon$$

where Y is the performance of road construction projects, QC quality control, QP quality planning, CC contractor competence and ε the error term. Data were checked for multivariate outliers with Mahalanobis distance (Tabachnick & Fidell, 2019) and missing values, and for normality using the Shapiro–Wilk (1965) test prior to analysis. The variance inflation factor (VIF) threshold of 5 was used and inter-correlations among predictors (Field, 2018) were also checked for multicollinearity. The recordings from interviews were transcribed and analyzed thematically using the phases of familiarity, coding, theming and reviewing (Braun & Clarke, 2006).

RESULTS AND DISCUSSION

Response Rate

Of the 161 participants targeted, 152 took part: 120 of the 126 questionnaires (95.2%) were returned complete and 32 of the 35 interviews (91.4%) were conducted, an overall response rate of 94.4% (Table 2). Response rates above 50% are generally regarded as adequate for statistical analysis (Saunders et al., 2019), so the data were sufficient for the planned analyses. The six non-returned questionnaires were treated as unit non-responses and no item-level missing data were reported in the 120 usable questionnaires. All quantitative analyses below are based on N = 120.

Table 2: Response Rate

Instrument	Targeted	Completed	Response rate (%)
Questionnaires	126	120	95.2
Interviews	35	32	91.4
Total	161	152	94.4

Source: (Author 2026)

Profile of Questionnaire Respondents

The respondents were mature and experienced (Table 3). The largest age group was 36–45 years (38.3%), 67.5% had more than five years of experience in road construction and 58.3% held a professional certification. Contractors and subcontractors formed the largest group (57.5%), followed by quality assurance/control officers (16.7%), which is consistent with the composition of the target population. Because most respondents held a diploma or higher qualification (86.6%) and many were directly responsible for the work being rated, they were well placed to judge the quality control practices examined.

Table 3: Profile of Questionnaire Respondents (N = 120)

Characteristic	Category	Frequency	Percent (%)
Age group	Below 25 years	8	6.7
	26–35 years	34	28.3
	36–45 years	46	38.3
	46–55 years	24	20.0
	Above 55 years	8	6.7
Highest education	Certificate	11	9.2
	Diploma	31	25.8
	Bachelor's degree	54	45.0
	Postgraduate	19	15.8
	Other	5	4.2
Stakeholder category	County Roads and Infrastructure Committee	11	9.2
	Contractors and subcontractors	69	57.5
	Project managers and engineers	11	9.2
	Quality assurance/control officers	20	16.7
	Procurement officers	9	7.5
Experience in road construction	Less than 2 years	9	7.5
	2–5 years	30	25.0
	6–10 years	51	42.5
	Above 10 years	30	25.0
Professional certification	Yes	70	58.3
	No	50	41.7

Source: (Author 2026)

Descriptive Statistics: Quality Control

Respondents rated quality control practices favourably, with a composite mean of 3.95 (SD = 0.79), which lies close to the "agree" point of the five-point scale (Table 5). Regular site inspections received the highest rating (M = 4.08, SD = 0.73), followed by workmanship monitoring (M = 4.00), compliance with technical standards (M = 3.95) and testing of materials before use (M = 3.92). Early identification and correction of defects was the lowest-rated practice (M = 3.79, SD = 0.86) and had the widest dispersion, which indicates that corrective action was the least consistently implemented component of quality control. The pattern, in which monitoring activities score higher than corrective action, is consistent with a system that is better at detecting non-conformance than at closing it out quickly, a pattern also suggested by the training and implementation gaps reported in South African road projects (Nyakala et al., 2019).

Table 4: Descriptive Statistics for Quality Control (N = 120)

Statement	Mean	SD
Regular site inspections were conducted during road construction	4.08	0.73
Construction materials were tested before use	3.92	0.81
Workmanship was monitored during project implementation	4.00	0.77
Defects were identified and corrected early	3.79	0.86
Road projects complied with technical standards	3.95	0.80
Composite mean	3.95	0.79

Source: (Author 2026)

Descriptive Statistics: Performance of Road Construction Projects

Project performance was rated at a composite mean of 3.79 (SD = 0.89), lower than the rating given to quality control (Table 6). Access to markets and services was the highest-rated outcome (M = 4.02), followed by compliance with technical specifications (M = 3.86) and community satisfaction (M = 3.78). Budget adherence (M = 3.73) and timely completion (M = 3.69) were rated lower, and the need for only minimal corrective maintenance after completion was the lowest-rated outcome (M = 3.65, SD = 0.98). The largest dispersion on this item points to uneven experience of road durability across projects. The weakest quality control practice (early defect correction) and the weakest performance outcome (low post-completion maintenance) are thematically linked: defects that are not corrected during construction are likely to reappear as maintenance needs after handover. This reading is suggestive only, since the two items were not analyzed against each other.

Table 5: Descriptive Statistics for Project Performance (N = 120)

Statement	Mean	SD
Road projects were completed within the allocated budget	3.73	0.92
Road projects were completed within scheduled timelines	3.69	0.95
Completed roads met required technical specifications	3.86	0.84
Completed roads required minimal corrective maintenance after completion	3.65	0.98
Road projects improved access to markets and services	4.02	0.77
Community members and beneficiaries were satisfied with completed road projects	3.78	0.89
Composite mean	3.79	0.89

Source: (Author 2026)

Correlation Analysis

Quality control showed positive and statistically significant correlation with project performance ($r=.712$, $p<0.01$). This means that there is a very strong linear relationship; higher levels of quality control are linked to higher levels of project performance.

Table 6: Correlation Matrix (N = 120)

Variable	1
1. Quality control	1
2. Project performance	0.712**

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

Source: (Author 2026)

Regression Analysis: Quality Control and Project Performance

Quality control alone. Performance was regressed on quality control only (Table 7). The model was significant $p < 0.001$, with $R = 0.712$, $R^2 = 0.507$ and adjusted $R^2 = 0.503$. Quality control alone therefore accounted for 50.7% of the variance in project performance, a large effect (Cohen's $f^2 \approx 1.03$; Cohen, 1988). The unstandardized coefficient was $B = 0.802$ ($SE = 0.073$; approximate 95% CI 0.66 to 0.95), the standardized coefficient $\beta = 0.712$ and $t = 11.015$, $p < 0.001$. The estimated equation was $\text{Performance} = 0.622 + 0.802(\text{QC})$: a one-point increase in the quality control score was associated with a 0.802-point increase in the performance score. On this basis the null hypothesis was rejected.

Table 7: Simple Regression of Project Performance on Quality Control

Section	Statistic	Value				
Model Summary	R	0.712				
	R^2	0.507				
	Adjusted R^2	0.503				
ANOVA		Sum of Squares	df	Mean Square	F	Sig.
	Regression	47.790	1	47.790	121.324	< 0.001
	Residual	46.470	118	0.394		
	Total	94.260	119			
Coefficients		B	Std. Error	Beta	t	Sig.
	Constant	0.622				
	Quality Control	0.802	0.073	0.712	11.015	< 0.001

Source: (Author 2026)

Hierarchical regression was used to explore the relationship between quality control and project performance (Table 8). The independent variable (IV) for the quality control was project performance, and the dependent variable (DV) was project performance. The model was statistically significant $F(2,117) = 81.452$, $p < .001$, accounting for 58.2% of the variance in project performance ($R^2 = .582$, adjusted $R^2 = .575$). The inclusion of quality control increased the explained variance by 11.4% ($R^2 = .114$) and added a medium to large effect size ($f^2 = 0.27$) to the model, which is a large unique contribution (Cohen, 1988). From the results, it is concluded that quality control is one of the key determinants of project performance in road construction projects and it is statistically significant.

Table 8: Hierarchical Regression Model Summary

Model	Predictors entered	R	R ²	Adjusted R ²	R ² change	F (df)	Sig.
2	+ Quality control	0.763	0.582	0.575	0.114	81.452 (2, 117)	< 0.001

Finally, the final model (see Table 9) suggested that quality control is a positive and statistically significant predictor of project performance ($B = 0.287$, $SE = 0.074$, $\beta = 0.306$, $t = 3.878$, $p < .001$; approximate 95% CI [0.14, 0.43]). This suggests that, while other practices in the model were controlled for, there were higher levels of quality control that led to higher levels of project performance.

Table 9: Final Regression Coefficients (Dependent variable: project performance)

Predictor	B	Std. error	Beta	t	Sig.
Constant	0.612	0.214		2.860	0.005
Quality control	0.287	0.074	0.306	3.878	< 0.001

Note: 95% confidence intervals and Cohen's f^2 values quoted in the text were calculated from the reported B, SE and R^2 values.

Source: (Author 2026)

Qualitative Findings from Community Interviews

Thematic analysis of the 32 interviews produced six themes (Table 11). Those most relevant to quality control concerned the perceived quality of completed roads and suggestions for improvement. Community representatives judged quality through what they could observe and use: workmanship, drainage, durability, the quality of materials and the appearance of defects after completion. Some participants raised concerns about poor drainage, visible defects, premature

deterioration and workmanship on completed roads, and associated delays and unfinished works with funding delays, contractor delays, approval delays, equipment shortages and inadequate materials. When asked how future projects could be improved, they called for stronger supervision, regular inspection, timely maintenance and close monitoring of construction activities. The interviews therefore corroborate the statistical result from a different vantage point: where inspection, supervision and defect correction are weak, the consequences are visible to road users after handover.

Table 10: Themes from Community Interviews (n = 32)

Theme	Sub-themes	Relevance to quality control
Community involvement in planning	Early consultation; public meetings; priority road identification; feedback	Aligns road projects with local access needs; context for control variable
Perceived quality of completed roads	Workmanship; drainage; durability; material quality; defects after completion	Direct indicator of the outcome of quality control
Delays in project completion	Funding delays; contractor delays; weather; approval delays; equipment shortages	Delays reduce usability and confidence in county delivery
Budget and resource concerns	Cost overruns; inadequate materials; delayed payments; limited maintenance funds	Resource limits constrain testing, finishing and maintenance
Satisfaction with outcomes	Access to markets, schools and health facilities; reduced transport challenges	Satisfaction highest where roads improved mobility
Suggestions for improvement	Stronger supervision; regular communication; community monitoring; timely maintenance; competent contractors	Calls for more inspection and oversight

Source: (Author 2026)

Discussion

Quality control and project performance. The study found that quality control was positively and significantly related to the performance of county road projects, that it was the strongest correlate of performance among the quality management practices studied, and that it kept the largest standardized coefficient after adjusting for planning, contractor competence and stakeholder involvement. These results are consistent with the logic of the Quality Trilogy, in which control closes the gap between actual and planned performance (Juran & Godfrey, 1999), and with Deming's (1986) argument that quality must be achieved within the process rather than discovered at the end. They are also consistent with the Kenyan evidence that inspection was a significant predictor of road project performance in Wajir County (Mohamed, 2023) and that quality management approaches influenced the effectiveness of KeRRA projects in Kirinyaga County (Mwangi, 2023). The magnitude of the explained variance in this study (68.7% for the full

model) is of the same order as that reported for planning practices in Nairobi Road projects (68.7%; Nyakundi & Wanjiru, 2025) and for project management practices (about 77%; Mongina & Moronge, 2021), which suggests that the practices examined account for a large share of the variation in how road projects are judged.

Detection versus correction. The descriptive results show a gap between the activities that detect problems (inspection, workmanship monitoring) and the activity that resolves them (early correction of defects). A comparable pattern of high perceived importance but weaker implementation of supporting capacity, particularly training, was reported among South African road contractors (Nyakala et al., 2019), and Rubaratuka (2018) concluded that quality control was generally not properly carried out on building sites in Dar es Salaam. The weakest-rated performance outcomes in Nyamira, namely timely completion, budget adherence and low post-completion maintenance, are the outcomes through which uncorrected defects would be expected to appear, because rework consumes time and money (Love & Li, 2000; Josephson & Hammarlund, 1999). Taken with the interview themes of poor drainage, visible defects and premature deterioration, the findings suggest that the greatest return from strengthening quality control in Nyamira lies in closing the loop from detection to prompt correction.

Why the coefficient is smaller with controls. The drop in the quality control coefficient from 0.802 to 0.287 should not be read as a weaker effect. The simple coefficient captures the association of quality control together with whatever it shares with planning, contractor capability and stakeholder engagement; the final coefficient captures only its distinct contribution. That the distinct contribution remains the largest and is highly significant indicates that quality control is not merely a proxy for a generally well-managed project. In practical terms, quality control capacity is not substituted by good planning, capable contractors or community consultation.

Implications for theory. The findings support TQM and Quality Trilogy propositions in a devolved, resource-constrained public infrastructure setting, where the literature has most often questioned their applicability (Haupt & Whiteman, 2004). They also support the risk perspective: the activities that detect non-conformity early are those most strongly associated with better outcomes. Stakeholder theory is supported by the independent contribution of stakeholder involvement and by community interviews, which show that road users evaluate quality by what they experience after handover.

Caution in interpretation. The design is correlational and the data are perceptual, so the results indicate association rather than causation. Respondents who rate quality control highly may also rate outcomes generously (common-method bias), and the contractors who dominate the sample may rate their own work more favorably. The interview data and the modest, differentiated ratings across items (rather than uniformly high scores) provide some reassurance but not a substitute for objective project records.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary of Findings

The study examined the relationship between quality control and the performance of road construction projects implemented by the County Government of Nyamira between 2019 and 2024. Of 161 targeted participants, 152 responded (94.4%): 120 completed questionnaires were analyzed quantitatively, and 32 community interviews were analyzed thematically. Quality control was rated favorably ($M = 3.95$, $SD = 0.79$), with site inspection rated highest ($M = 4.08$) and early identification and correction of defects rated lowest ($M = 3.79$). Project performance was rated lower ($M = 3.79$), with minimal post-completion maintenance ($M = 3.65$) and timely completion ($M = 3.69$) the weakest outcomes. Quality control correlated strongly and significantly with performance ($r = 0.712$, $p < 0.01$), explained 50.7% of its variance on its own ($B = 0.802$, $p < 0.001$) and, with quality planning, contractor competence and stakeholder involvement held constant, remained the strongest predictor ($\beta = 0.306$, $B = 0.287$, $p < 0.001$). The full model explained 68.7% of the variance in performance (adjusted $R^2 = 0.676$). Interviews showed that communities judge quality by workmanship, drainage, durability, materials and visible defects, and called for stronger supervision, regular inspection and timely maintenance.

Conclusions

The study concludes that quality control has a positive and statistically significant relationship with the performance of road construction projects in Nyamira County, and the null hypothesis is therefore rejected. Quality control is the practice most strongly associated with performance among those studied, and its association is not explained away by planning, contractor competence or stakeholder involvement. The practices that detect non-conformance (inspection, workmanship monitoring) are better established than the practice that resolves it (early defect correction), and the outcomes most likely to reflect uncorrected defects, namely timeliness, budget adherence and post-completion maintenance, are the ones rated lowest. Quality control in Nyamira's road projects is therefore valued and practiced, but its closing step, timely correction and verification, is the main opportunity for improvement. Because the design is correlational and the measures are perceptual, these conclusions describe associations and should be tested against objective project records.

Recommendations

For the County Government of Nyamira (Department of Transport, Roads, Public Works).

1. Make documented inspection and testing plans mandatory for every road project, specifying what is inspected and tested at each stage and layer, how often, by whom and against which standard, and require approval of each stage only after recorded inspection results and closure of open defects.

2. Resource materials testing. Allocate budget and arrange access to laboratories so that construction materials are tested before use and works are tested at agreed frequencies, including strength testing such as cube testing, as recommended for Wajir County by Mohamed (2023).
3. Introduce a defect management procedure: a register of non-conformities, an assigned responsible person, a deadline for rectification and written verification of closure. This targets the lowest-rated quality control practice.
4. Build supervision capacity. Provide trained quality control staff, transport and equipment so that supervisors can be present on remote sites, and invest in recurrent QA/QC training, the area found weakest in comparable road-sector studies (Nyakala et al., 2019).
5. Link payment and acceptance to quality control evidence. Make inspection records and test results a condition for certification of interim payments and handover, and apply contractual corrective measures to contractors that repeatedly fail to meet quality requirements.
6. Keep and use records. Store inspection reports, test results, defect registers and post-completion road condition assessments, and use them in future procurement, budgeting and maintenance planning.

For contractors and project managers. Contractors should maintain their own site quality control systems, with competent personnel and calibrated equipment on site, and should correct defects promptly rather than waiting for formal instructions. Project managers should hold regular quality review meetings and record decisions.

For policy. The County Government should adopt a county road quality management policy that integrates quality control with quality planning, contractor competence and stakeholder involvement and sets a minimum budget share for supervision and testing. Community feedback and monitoring arrangements should complement, and not replace, professional engineering supervision and quality control.

Limitations of the Study

The study was limited to one county and a defined period, and relied on perceptual questionnaire data. Contractors formed the largest respondent group, which may bias ratings of quality control and outcomes. Some respondents were in remote locations managing several projects and others were initially reluctant to respond, citing lack of authority to release information; these challenges were managed by rescheduling and by presenting the NACOSTI permit and introduction letter. Community representatives initially perceived the study as political, which was addressed by clarifying its academic purpose. The cross-sectional correlational design prevents causal inference.

Areas for Further Research

Similar studies should be conducted in other counties to test whether the relationship holds under different administrative, financial and contractor-market conditions. Second, future work should combine perceptual data with objective records such as inspection reports, laboratory test results, payment and budget records, completion certificates and road condition surveys, so that quality control and performance are not both drawn from the same respondents. Third, longitudinal studies should track the condition, durability and maintenance needs of completed roads to establish whether construction quality is sustained over time. Fourth, the 31.3% of unexplained variance indicates that other factors, such as financial capacity, procurement delays, weather, project governance, availability of materials, design changes and institutional capacity, should be investigated, including whether they moderate the effect of quality control.

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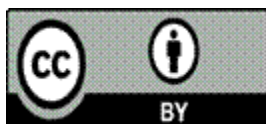
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