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Effect of Quality Control Implementation on Information and Communication Technology Infrastructure Performance: A Case Study of Short Message Service Gateway Project at Ishema Hub in Kigali City, Rwanda

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Abstract: *This study assessed the effect of quality control implementation on Information and Communication Technology (ICT) infrastructure performance in the Short Message Service (SMS) Gateway project at Ishema Hub in Kigali City, Rwanda. The study examined quality inspection/testing, quality standards compliance, reporting, and corrective action implementation as predictors of ICT infrastructure performance. Total Quality Management Theory, Systems Theory, the Information Systems Success Model, and Continuous Improvement Theory guided the analysis. Descriptive and correlational research designs were adopted using a quantitative approach. The target population comprised 92 respondents directly connected to the SMS Gateway project, and the study used a census approach. Data were collected through questionnaires and documentation review. Quantitative data were analysed using SPSS version 29 through frequencies, percentages, means, standard deviations, Pearson correlation, and multiple linear regression at the 0.05 significance level. Regression results showed that quality inspection/testing ($B = 0.353$; $t = 3.922$; $p = 0.000$), quality standards compliance ($B = 0.181$; $t = 2.321$; $p = 0.023$), reporting ($B = 0.271$; $t = 3.430$; $p = 0.001$), and corrective action implementation ($B = 0.209$; $t = 3.215$; $p = 0.002$) had positive and significant effects on ICT infrastructure performance. The model explained 79.9% of the variation in ICT infrastructure performance. The study concluded that coordinated testing, standards compliance, reporting, and corrective action strengthened platform availability, security, speed, and service continuity. It recommended documented quality-control cycles, routine compliance checks, standardized reporting, and corrective-action tracking.*

Keywords: *Quality Inspection, Testing, Quality Standards Compliance, Reporting, Corrective Action Implementation, ICT Infrastructure Performance*

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1. Introduction

Quality control implementation plays a crucial role in Information and Communication Technology infrastructure performance because it provides systematic procedures for checking conformance, identifying faults, documenting deviations and confirming system readiness before users depend on a digital service. In project environments, quality control supports service continuity, reliability, security, usability, maintainability and timely restoration of digital systems. Information and Communication Technology infrastructure supports project coordination, digital service delivery, data exchange and institutional communication, but these benefits are achieved only when quality requirements are verified during project execution and operation (Khasawneh & Dweiri, 2024).

In Rwanda, digital government, smart city initiatives, broadband expansion and technology-supported services

have increased the need for quality control in Information and Communication Technology infrastructure projects. Kigali digital mobility initiatives show that digital systems must remain functional, accurate, secure, continuous and responsive to user needs during implementation. This country profile justifies attention to quality control practices that protect service reliability in Rwanda-based digital projects (Boutueil & Lesteven, 2024).

At project level, Ishema Hub provides technology solutions in software engineering, enterprise resource planning, business intelligence, data science, artificial intelligence, financial technology and business integration. Its Short Message Service Gateway facilitates the sending and receiving of Short Message Service messages between computer systems or applications and mobile devices through telecommunications networks, and it is also presented as high-throughput messaging infrastructure for transactional and promotional messages. This makes the Short Message Service Gateway project an appropriate case for examining how quality inspection/testing, standards compliance, reporting and corrective action implementation influence infrastructure performance, message delivery reliability, service continuity, secure integration and user trust (Ishema Hub, 2026).

Rwanda's ICT infrastructure has expanded, but service performance still faces weaknesses in access continuity, broadband depth, user connectivity, and effective digital-service use. Internet subscriptions increased slightly from 10,131,037 in the first quarter of 2025 to 10,195,972 in the second quarter, representing only 0.6% growth (Rwanda Utilities Regulatory Authority, 2025). The ICT Sector Strategic Plan also showed that 4G mobile network geographical coverage was 75% against a 100% target, indicating that national connectivity remained below the desired level (Ministry of ICT and Innovation, 2024). These gaps show that infrastructure performance remains a practical concern for digital services that depend on availability, speed, reliability, and secure connectivity.

The problem is also reflected in limited digital capacity among users and institutions. National computer literacy remained at 12.8%, with lower levels in rural areas and higher levels in urban areas, which affected effective use of digital platforms (National Institute of Statistics of Rwanda, 2025). Education-sector evidence showed that only 62% of schools had internet connection and 65.2% of school computers were operational, confirming that infrastructure availability and performance were still uneven (Ministry of Education, 2024). These conditions demonstrate that ICT infrastructure performance is not only a question of installed technology, but also of service dependability, usability, and operational support.

At Ishema Hub, the Short Message Service Gateway project depends on continuous message routing, high-throughput processing, secure system integration, delivery feedback, platform availability, and accurate incident reporting. Weak quality inspection/testing, limited standards compliance, poor reporting, and delayed corrective action can lead to message delays, repeated faults, weak data protection, unresolved incidents, and reduced client confidence. Such weaknesses would directly affect network uptime, system speed, platform availability, data security, message delivery reliability, and service continuity within the project.

Previous Rwandan studies examined ICT implementation and project performance in wider settings, but they did not provide project-specific evidence on how quality control implementation affects ICT infrastructure performance in a Short Message Service Gateway project. This created a knowledge gap concerning the effect of quality inspection/testing, quality standards compliance, reporting, and corrective action implementation at Ishema Hub. Therefore, this study assessed the effect of quality control implementation on ICT infrastructure performance in the SMS Gateway project at Ishema Hub in Kigali City, Rwanda.

1.1 General Objective

The general objective was to assess the effect of quality control implementation on ICT infrastructure performance in SMS Gateway project at Ishema Hub in Kigali City, Rwanda.

1.2 Specific Objectives

1. To examine the effect of quality inspection/testing on ICT infrastructure performance in SMS Gateway project at Ishema Hub.
2. To determine the effect of quality standards compliance on ICT infrastructure performance in SMS Gateway project at Ishema Hub.
3. To assess the effect of reporting on ICT infrastructure performance in SMS Gateway project at Ishema Hub.
4. To examine the effect of corrective action implementation on ICT infrastructure performance in SMS Gateway project at Ishema Hub.

2. Literature Review

2.1 Theoretical Review

The theoretical review presented the theories used to explain the relationship between quality control implementation and ICT infrastructure performance. The study was based on Total Quality Management Theory, Systems Theory, the Information Systems Success Model and Continuous Improvement Theory. These theories addressed the four specific objectives and explained how quality control practices influenced ICT infrastructure performance.

2.1.1 Total Quality Management Theory

The roots of Total Quality Management Theory stem from quality management activities related to W.

Edwards Deming, Joseph Juran and Philip Crosby and had significant development in the 1950's and 1980's. It is a theory that gives priority to the customer, having strict control over processes, involving staff member, measurement, and continuous improvement. It provides a definition of quality not as a last inspection activity but as a responsibility of all the organization. In the present day, literature still considers TQM as a base for systematic improvement of performance and reduction of defects (Lima et al., 2025).

Total Quality Management Theory was applied to quality inspection and testing to provide a deeper understanding of how this quality control practice influenced ICT infrastructure performance in the SMS Gateway Project at Ishema Hub. Specifically, the theory explained how test coverage, defect detection, load testing, security testing and acceptance testing helped improve system speed, platform availability, data security, message delivery reliability and service continuity.

2.1.2 Systems Theory

In 1968 Systems Theory was furthered by Ludwig von Bertalanffy who described an organization or nature as a system comprised of interrelated parts. The theory sees performance as an outcome of the interaction of Inputs, Processes, Outputs, Feedback and Environment. It assists in the research of why one part of a system can be bad and the entire system suffers. Systems thinking is still applied to information on relationships between complex performances in more recent project and digital infrastructure literature (Storey et al., 2024).

Systems Theory was applied to quality standards compliance to deepen the understanding of how this practice influenced ICT infrastructure performance in the SMS Gateway Project at Ishema Hub. The theory explained how security, service, documentation, access and data compliance interacted with organizational procedures, personnel and technology to support effective service outcomes.

2.1.3 The Information Systems Success Model

William DeLone and Ephraim McLean came up with the Information Systems Success Model in 1992. System quality, information quality, service quality, use, user satisfaction, and net benefits are all reinforcing factors to explain information system success through the model approach. It has been well used in the digital service evaluation, as it connects technology quality to the results for the user. These quality dimensions are still used in recent information system research, for the explanation of service performance and satisfaction (Abdullah et al., 2024).

The Information Systems Success Model provided a framework for understanding quality reporting within the SMS Gateway Project at Ishema Hub. It explained how incident, downtime, testing, compliance and performance reports captured technical events and informed decisions aimed at improving system quality, information quality, service quality and user satisfaction.

2.1.4 Continuous Improvement Theory

Continuous Improvement Theory is often referred to the Plan Do Check Act cycle, known throughout the world because it was popularized through Deming in 1950, following work with Walter Shewhart in 1939. The theory is the way of continual change, of planning, doing, checking and modifying. It has vast applications in quality management for it leans towards small repetitive enhancements rather than single fixes. The concept is still used in current quality research for the improvement or prevention of defects in the operating process (Lima et al., 2025).

Continuous Improvement Theory provided a basis for examining corrective action implementation in the SMS Gateway Project at Ishema Hub. It explained how root cause analysis, fault correction, patch implementation, action tracking and preventive actions helped minimise recurring errors, maintain service continuity and strengthen customer trust..

2.2 Empirical Review

The empirical review synthesised evidence from previous studies concerning quality control practices and the performance of ICT infrastructure. Attention was given to research on quality inspection and testing, quality standards compliance, quality reporting and corrective action implementation. Studies from international, regional and Rwandan contexts were assessed based on their methodologies, findings and conclusions. This assessment established what is already known, identified inconsistencies and unresolved issues in the existing evidence, and demonstrated the need to investigate these practices within the SMS Gateway Project at Ishema Hub in Kigali City.

2.2.1 Quality Inspection/Testing and ICT Infrastructure Performance

Mobile applications must remain responsive and accessible under different levels of demand. Against this background, Tariq (2025) explored performance testing and quality assurance practices in seven prominent organisations. Using a mixed-methods approach that combined a systematic literature review with evidence from mobile application environments, the research considered load, stress, endurance and spike testing. These testing practices were found to validate platform reliability and user experience, particularly where customers expected rapid responses and stable access. Regular performance testing was consequently proposed as part of software development and maintenance.

Rather than assuming that every test case contributes equally to software quality, Lucrédio et al. (2023) investigated the actual effectiveness of test cases found in open software repositories. Eight hypotheses concerning

the use of appropriate test cases were empirically assessed. Only weak evidence was found regarding the characteristics that make a test effective. This outcome underscored the importance of evaluating testing practices through measurable defect-detection results and evidence obtained from actual projects.

Evidence from the Kenyan software industry offers an African perspective on the application of software quality assurance. Wambua and Maake (2022) collected and analysed 77 questionnaires from software developers through a quantitative survey. Unit testing emerged as the most commonly applied testing technique, while weak compliance with software development life cycle models remained a threat to product quality. Although testing contributed to software improvement, differences in its application created performance risks. Wider adoption of quality assurance practices and further training for software teams were therefore recommended.

Automated inspection can complement conventional testing by detecting defects across different programming environments. Yeboah and Popoola (2024) compared SonarQube, PMD, Checkstyle and FindBugs using Java, C++ and Python repositories. SonarQube achieved better defect-detection results than the other tools across the three programming languages. Based on this comparison, automated analysis tools were considered useful for strengthening software reliability and quality. Careful selection and continuous improvement of such tools were identified as necessary for better system dependability.

Rwandan evidence was provided by Mukamihigo and Musoni (2024), who assessed ICT implementation and project performance at the Rusumo Cross Border Market Project. A descriptive design with a correlational approach was adopted, and questionnaire data were obtained from project stakeholders. The results established a positive relationship between ICT usage and project performance, especially through improved communication and data sharing. ICT was considered more beneficial when both systems and users were adequately prepared. Nonetheless, the study addressed general ICT implementation rather than quality inspection and testing in SMS Gateway infrastructure, leaving a contextual gap that the present study sought to address.

2.2.2 Quality Standards Compliance and ICT Infrastructure Performance

Compliance systems provide organisations with structured mechanisms for maintaining consistent processes. Malega and Majerník (2024) analysed the possible implementation approaches and benefits of compliance management within organisational practice. Standardisation was associated with process quality, sustainability and greater management consistency. The analysis further indicated that compliance practices could strengthen organisational controls when incorporated into existing systems. Progressive integration of quality, compliance and sustainability systems was proposed.

From a digital-platform perspective, Park and Park (2024) considered whether the quality of available information influenced customer decisions in South Korea. The quantitative model distinguished between platform-oriented and customer-oriented information quality. Screening costs, evaluation costs and decision quality were all affected by the quality of information provided through the platform. Information standards were therefore relevant to customer choice, confidence and online-service effectiveness. Continuous refinement of those standards was recommended to improve the value of the system.

A broader synthesis of information and system quality was undertaken by Abd Aziz et al. (2024). Through a systematic literature review, evidence concerning information-quality factors, system-quality relationships and user outcomes was organised and assessed. The review linked quality dimensions with system usefulness, satisfaction and service performance. It also demonstrated the importance of consistent standards when measuring digitally delivered services. Transparent measurement systems were recommended for information-systems research and practice.

Security compliance within ICT systems is also shaped by internationally recognised requirements. International Organization for Standardization (2022) outlined provisions for establishing, implementing, maintaining and continually improving information security management systems. Its requirements centred on confidentiality, integrity and availability and called for formal controls to protect information assets. Risk treatment, access control, monitoring and continuous improvement were presented as essential practices for secure digital operations. Although this standard provided technical guidance, it did not supply empirical evidence from an organisational case.

Within Rwanda, the ICT Sector Strategic Plan 2024–2029 provided evidence on the condition of national digital infrastructure. Ministry of ICT and Innovation (2024) reported that geographical 4G coverage stood at 75%, while 60% of schools had been connected to 4G internet and 22.8% of households had internet access. These indicators revealed continuing limitations in broadband accessibility and preparedness for digital services. The plan prioritised stronger connectivity, digital public services and supporting infrastructure. However, it did not determine whether security, service, documentation, access and data compliance affected the performance of the SMS Gateway Project at Ishema Hub.

2.2.3 Reporting and ICT Infrastructure Performance

Prompt communication of incidents allows technical teams to understand interruptions and coordinate recovery activities. Atlassian (2024) surveyed more than 500 software developers, IT professionals and decision-makers in the United States regarding incident management. The report covered the management of incidents, disrupted services and related tasks within IT service management. Effective communication and

reporting were associated with faster responses, improved recovery and greater visibility of service problems. Clear incident procedures, a supportive reporting culture and stronger cooperation among technical teams were emphasised.

European experience illustrates the contribution of structured service management to complex information technology environments. Gösslbauer (2025) analysed how service-management approaches influenced system availability, incident handling and user support. Structured practices improved the visibility of performance factors and enabled teams to coordinate their responses more effectively. The analysis also recognised the need for clearly defined measures of IT service-management success. Robust reporting and service-improvement frameworks were proposed to support infrastructure performance.

The relationship between service information and resolution speed was demonstrated using customer data analysed by SolarWinds (2025). Teams equipped with generative artificial intelligence capabilities were compared with those operating without them. Ticket closure was 17.8% faster among users of these capabilities, whose average resolution time was 22.55 hours rather than 32.46 hours. Reporting, organised workflows and service data were identified as contributors to this improved efficiency. Their integration with automation was consequently encouraged.

Heavy workload can reduce the ability of service desks to respond efficiently to users. Ivanti (2024) approached this challenge by examining digital experience and IT service management, particularly automation, measurement, integration and self-service tools. The report indicated that service desks could use data more effectively to improve end-user experience. Reporting supported the prioritisation of tasks and the timely handling of service needs. Increased use of performance measurement and integrated management platforms was consequently proposed.

Abdullah et al. (2024) shifted attention to the measurement of information-system performance through system, information and service quality. A quantitative survey and statistical analysis produced a Cronbach's alpha of 0.953, a Kaiser–Meyer–Olkin value of 0.965 and a significant Bartlett's test result. The three quality dimensions contributed to user satisfaction and operational efficiency. This evidence supported the use of quality measures in assessing information systems and their service value. Since none of the available studies examined quality reporting in a Rwandan SMS Gateway environment, the current study addressed an important geographical and contextual gap.

2.2.4 Corrective Action Implementation and ICT Infrastructure Performance

Defect-reduction plans are most useful when they identify practical changes that can be implemented during software maintenance. Oueslati et al. (2024) evaluated CounterACT against six other defect-reduction methods using nine software projects. Its plans achieved median overlap scores of 0.95 at the release level and 0.8597 at the commit level, alongside a median F1 score of 0.8812. These results supported the value of action-based planning in improving software quality. Explainable plans were proposed as a means of guiding fault correction and maintenance decisions.

Early identification of defect-prone software components can prevent failures from reaching end users. To examine this possibility, Albattah and Alzahrani (2024) compared eight machine-learning and deep-learning algorithms using accepted datasets and performance measures. The predictive models successfully identified software areas that were likely to contain defects before operational failure occurred. Such prediction was considered relevant to proactive quality assurance and corrective planning. Continued evaluation of the models was advised to strengthen software reliability and maintainability.

Corrective action also depends on whether team members are willing to disclose and discuss quality problems. Alami et al. (2024) investigated this behavioural dimension through 20 interviews and a survey involving 423 participants from agile teams. A supportive team environment encouraged defect discussion, quality-related behaviour and willingness to resolve identified problems. Open reporting was more likely where team members could raise concerns without fear. The researchers therefore called for organisational conditions that supported transparent defect handling and corrective action.

Large software repositories provide further evidence about the role of automation in correcting defects. Yousuf and Sofi (2025) analysed 322,960 verified bug reports collected from 123 open-source quantum software repositories between 2012 and 2024. Automation users detected more defects and corrected them in less time, while repositories applying automated testing recorded a 60% reduction in expected defect incidence. The evidence connected testing and corrective practices with improved reliability. Better documentation, testing and maintainability practices were recommended.

In Rwanda, Uwiringiyimana et al. (2025) investigated ICT adoption and the performance of agriculturally based microenterprises in Gatsibo District using 300 respondents. ICT was used in 22% of the cases, 80% lacked access to technology and 75.7% identified the cost of devices and services as a challenge. These conditions limit digital performance in environments with inadequate access and capacity. Competitive pricing, electronic learning and improved infrastructure were proposed as possible responses. Although the study provided local ICT evidence, it did not examine root cause analysis, fault correction, patch implementation, action tracking or preventive action within SMS Gateway infrastructure.

3. Methodology

This section described the methodological procedures followed in examining quality control implementation and ICT infrastructure performance in the SMS Gateway Project at Ishema Hub. It covered research design, target population, sample size, sampling techniques, data collection methods, research instruments, validity, reliability, data analysis procedures and ethical considerations. These procedures provided a systematic basis for collecting and analysing credible data on quality inspection and testing, quality standards compliance, quality reporting, corrective action implementation and ICT infrastructure performance.

3.1 Research Design

Research design is a blueprint for conducting a study, which includes a plan on how the study collected, measured, and analyzing data to solve research questions. It relates the research problems and the method, apparatus, sampling and analysis. Descriptive, correlational, quantitative and qualitative designs are used when it is necessary to describe variables and examine relationships within the study (Creswell & Creswell, 2023).

Descriptive and correlational research designs were conducted with a quantitative approach. The descriptive design helped the researcher describe quality inspection/testing, quality standards compliance, reporting, corrective action implementation and ICT infrastructure performance in SMS Gateway project. The correlational design determined whether each quality control dimension has a statistical relationship and effect on ICT infrastructure performance.

3.2 Study Population

A study population comprises the individuals or units from which relevant information is obtained (Saunders et al., 2023). This study targeted 92 respondents connected to the SMS Gateway Project at Ishema Hub, including project management, software development, ICT support, quality assurance, operations, customer support and business development staff, together with selected institutional clients. Their involvement enabled them to provide information on quality control implementation and ICT infrastructure performance.

3.3 Sampling Design

Sampling design is a process to select a manageable number of respondents from the target population. It describes the number of samples, sampling method and distribution of samples according to each category. A well-designed sampling method allows the researcher to gather information more reflective of the population and obtain conclusions that are valid (Saunders et al., 2023).

Since this study used census sampling, all members of the target population were included as respondents. Therefore, no sample size formula was applied because the population is small, specific and manageable. The sample size was therefore equal to the target population of 92 respondents.

The use of census allowed the researcher to collect information from all relevant categories connected to the Short Message Service Gateway project at Ishema Hub. This helped the study capture both technical and user perspectives on quality inspection/testing, quality standards compliance, reporting, corrective implementation and Information and Communication Technology infrastructure performance.

3.4 Data Collection Instrument

Documentation is a data collection approach dependent upon written, electronic and institutional records as sources of information. Documents become useful records for the understanding of procedures, trends, policies, reports, and historical records related to the area of interest. Documentary evidence can be used to support research where relevant, authentic and goals of the study correspond (Saunders et al., 2023).

The study was done through documentation that looks at available SMS Gateway project records relating to ICT infrastructure performance and quality control implementation. The researcher requested access to relevant records, including service records, incident records, testing reports, standards compliance documents, corrective action logs and performance reports.

A questionnaire is a structured tool consisting of questions or statements to be answered with predetermined types of responses. It is helpful to get quantitative information systematically from multiple respondents. When the items in a questionnaire are unambiguous, variable relevant, and measured in a uniform scale, it can help to analyze data statistically (Creswell & Creswell, 2023).

The study was carried out in the form of a close-ended questionnaire using a five-point Likert scale. The questionnaire had sections for demographic characteristics, quality inspection/testing, quality standards compliance, reporting, corrective action implementation and ICT infrastructure performance. These sections match the specific objectives and conceptual framework so that quantitative data can be analyzed descriptively and inferentially using SPSS version 29.

3.5 Pilot Study, Validity and Reliability

A pilot study was conducted with 20 respondents at Airtel Rwanda Plc, Kigali Service Centre. The site had a comparable digital messaging and telecommunications environment but was independent of the SMS Gateway

Project. The pilot assessed questionnaire clarity, completion time and respondent understanding.

Expert review established the instrument's validity. Of the 29 questionnaire items, 25 were rated as relevant, resulting in a Content Validity Index of 0.862. This exceeded the minimum benchmark of 0.70 and confirmed acceptable content validity.

Reliability was tested using pilot data in SPSS version 29. Cronbach's alpha coefficients were 0.846 for quality inspection/testing, 0.872 for quality standards compliance, 0.838 for reporting, 0.829 for corrective action implementation and 0.857 for ICT infrastructure performance. Each variable contained five questionnaire statements. Since all coefficients exceeded the acceptable threshold of 0.70, the questionnaire demonstrated good internal consistency and was considered reliable for the main study.

3.6 Data Analysis

Data from the questionnaires were analyzed using SPSS version 29. Means, standard deviations, frequencies and percentages were used for descriptive analysis. The testing of the effect of quality control implementation on the performance of the ICT infrastructure was undertaken via correlation and multiple regression in an inferential analysis.

Inferential Analysis assisted the researcher to test relationship and effect between variables. Each independent variable was correlated with the ICT infrastructure performance using bivariate correlation. Since the majority of the variables were measured by Likert scale composite scores, Pearson correlation was used in the research. A p value of 0.05 was used as statistical significance.

The effect of mixed factors, namely quality inspection/testing, quality standards compliance, reporting and implementation of corrective action was analyzed using multiple linear regression based on the performance of the ICT infrastructure.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

Where:

Y = ICT Infrastructure Performance
β_0 = Constant term
β_1–β_4 = Regression coefficients
X_1 = Quality Inspection/Testing
X_2 = Quality Standards Compliance
X_3 = Reporting
X_4 = Corrective Action Implementation
ε = Error term

3.7 Ethical Considerations

In the study, the responsible conduct was guided by ethical considerations. The researcher safeguarded the participants, adhered to institutional protocols and use information for academic purposes only. During all aspects of data collection and reporting, the study adhered to access, informed consent, confidentiality, privacy, anonymity, and voluntary participation.

4. Results and Discussions

This section presents the findings obtained from respondents involved in the SMS Gateway Project at Ishema Hub.

4.1 Response Rate

Response rate was used to determine the level of participation of respondents selected for the study.

Table 1: Response rate

Questionnaires	Frequency	Percentage (%)
Returned Complete	90	97.8
Returned Incomplete	1	1.1
Unreturned	1	1.1
Total	**92**	**100.0**

Source: Field data, 2026

Table 1 presents the questionnaire response rate for the Short Message Service Gateway project at Ishema Hub. Complete questionnaires were returned by 90 respondents (97.8%), providing the cases used in the quantitative analysis. One questionnaire (1.1%) was returned incomplete and was excluded, while one questionnaire (1.1%) was not returned. The high level of complete participation provided adequate coverage of the selected respondents and reduced the likelihood that non-response would materially weaken the field-data analysis.

4.2 Inferential Statistics

This section examines the relationships and predictive effects linking Quality Inspection/Testing, Quality

Standards Compliance, Reporting, and Corrective Action Implementation with ICT Infrastructure Performance in the Short Message Service Gateway project at Ishema Hub in Kigali City. Pearson correlation analysis establishes the direction, strength, and significance of each objective-specific relationship, while multiple regression assesses combined explanatory power, overall model significance, individual coefficients, collinearity, and the corresponding hypothesis decisions.

4.2.1 Correlation Analysis

Pearson correlation analysis was used to determine whether each independent variable was significantly related to ICT Infrastructure Performance. The interpretation focused only on the four relationships corresponding to the specific objectives, applying a 0.05 significance level to establish whether each association was statistically meaningful in the current study.

Table 2: Correlation between study variables and ICT Infrastructure Performance

		Quality Inspection/ Testing	Quality Standards Compliance	Reporting	Corrective Action Implementation	ICT Infrastructure Performance
Quality Inspection/ Testing	Pearson Correlation	1	.690**	.764**	.670**	.820**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	90	90	90	90	90
Quality Standards Compliance	Pearson Correlation	.690**	1	.707**	.659**	.754**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	90	90	90	90	90
Reporting	Pearson Correlation	.764**	.707**	1	.628**	.802**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	90	90	90	90	90
Corrective Action Implementation	Pearson Correlation	.670**	.659**	.628**	1	.742**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	90	90	90	90	90
ICT Infrastructure Performance	Pearson Correlation	.820**	.754**	.802**	.742**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	90	90	90	90	90

**. Correlation is significant at the .01 level (2-tailed).

Source: Field data, 2026

Table 2 shows that Quality Inspection/Testing was positively related to ICT Infrastructure Performance ($r = 0.820$; $p = 0.000$). Since $p < 0.05$, the relationship was statistically significant. This means that changes in quality inspection/testing were associated with changes in ict infrastructure performance. The finding confirms that the relationship examined under this objective was meaningful in the Short Message Service Gateway project at Ishema Hub in Kigali City.

This relationship aligns with Wambua and Maake (2022), who explains that disciplined software quality assurance supports system dependability by detecting defects, validating functionality, and confirming readiness before operational use. Testing gives technical teams structured evidence for correcting weaknesses, reducing avoidable service interruptions, and protecting users from faults that could compromise the reliability or security of a digital platform.

Quality Standards Compliance was positively related to ICT Infrastructure Performance ($r = 0.754$; $p = 0.000$). Since $p < 0.05$, the relationship was statistically significant. This means that changes in quality standards compliance were associated with changes in ict infrastructure performance. The finding confirms that the relationship examined under this objective was meaningful in the Short Message Service Gateway project at Ishema Hub in Kigali City.

This association resonates with Malega and Majerník (2024), whose work shows that standards and compliance procedures stabilize organizational processes by defining expected controls, responsibilities, records, and review mechanisms. Within technology services, consistent compliance supports secure access, controlled information handling, reliable operations, and accountability, thereby creating conditions in which infrastructure can deliver more predictable performance.

Reporting was positively related to ICT Infrastructure Performance ($r = 0.802$; $p = 0.000$). Since $p < 0.05$, the relationship was statistically significant. This means that changes in reporting were associated with changes in ict infrastructure performance. The finding confirms that the relationship examined under this objective was meaningful in the Short Message Service Gateway project at Ishema Hub in Kigali City.

This relationship is supported by Atlassian (2024), which emphasizes that incident and performance reporting strengthens service management by converting operational events into shared evidence for response, learning, and improvement. Reports enable teams to coordinate decisions, trace recurring issues, communicate with users, and determine whether corrective measures have restored the expected service condition.

Corrective Action Implementation was positively related to ICT Infrastructure Performance ($r = 0.742$; $p = 0.000$). Since $p < 0.05$, the relationship was statistically significant. This means that changes in corrective action implementation were associated with changes in ict infrastructure performance. The finding confirms that the relationship examined under this objective was meaningful in the Short Message Service Gateway project at Ishema Hub in Kigali City.

This result consent with Oueslati et al. (2024), who argue that defect-reduction planning becomes effective when organizations identify causes, select appropriate actions, implement changes, and verify whether recurrence has been reduced. Corrective processes therefore contribute to dependable systems by transforming technical problems into monitored improvements rather than allowing repeated faults to remain part of normal operations.

Collectively, the correlations demonstrate that every independent variable maintained a strong, positive, and statistically significant relationship with ICT Infrastructure Performance. The coefficients were all above 0.70, indicating that better application of the selected management practices was associated with stronger performance of the dependent variable. These results provided an appropriate basis for estimating the simultaneous regression model.

4.2.2 Regression Analysis

Multiple linear regression was applied to determine the combined and individual effects of the four independent variables on ICT Infrastructure Performance. The model summary assessed the strength and explanatory capacity of the model and the independence of errors, the ANOVA tested overall statistical significance, and the coefficients table estimated the direction, magnitude, significance, and collinearity condition of each predictor.

Table 3: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.894[a]	.799	.789	.14180	1.843

a. Predictors: (Constant), Corrective Action Implementation, Reporting, Quality Standards Compliance, Quality Inspection/Testing
b. Dependent Variable: ICT Infrastructure Performance

Source: Field data, 2026

Table 3 presents the model summary results ($R = 0.894$; $R^2 = 0.799$; Durbin-Watson = 1.843) for predicting ICT Infrastructure Performance. R showed the strong combined relationship between the four predictors and the dependent variable. R^2 indicated that 79.9% of the variation in ict infrastructure performance was explained jointly by the predictors, while the remaining 20.1% was attributable to other factors and random variation. The Durbin-Watson statistic was close to 2.000, suggesting acceptable independence of regression errors. The model therefore possessed substantial explanatory power within the Short Message Service Gateway project at Ishema Hub in Kigali City.

The explanatory pattern aligns with Khasawneh and Dweiri (2024), who present digital infrastructure performance as an outcome of interacting with technical and managerial factors rather than a single isolated practice. Their framework suggests that reliable digital services depend on coordinated controls, information, technology readiness, and operational decisions, making a combined model appropriate for understanding performance in a complex messaging environment.

The model is supported by Mukamihigo and Musoni (2024), whose work links ICT-related management practices with improved project performance through better information use, coordination, service delivery, and operational control. This perspective supports the treatment of multiple quality-control dimensions as complementary influences that jointly shape the capability of infrastructure to deliver consistent value to users.

Table 4: ANOVA results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.784	4	1.696	84.800	.000[b]
	Residual	1.709	85	.020		
	Total	8.493	89			

a. Dependent Variable: ICT Infrastructure Performance

b. Predictors: (Constant), Corrective Action Implementation, Reporting, Quality Standards Compliance, Quality Inspection/Testing

Source: Field data, 2026

Table 4 reports that the regression model was statistically significant (F = 84.800; p = 0.000). The F statistic demonstrated that the four predictors jointly explained meaningful variation in ICT infrastructure performance. Since the significance value was below 0.05, the null proposition that the model lacked explanatory value was not supported. This means that the independent variables jointly predicted ICT infrastructure performance in the Short Message Service Gateway project at Ishema Hub in Kigali City. The ANOVA result therefore confirmed that interpretation of the individual coefficients was statistically justified.

The joint significance of the management dimensions resonates with Abdullah et al. (2024), who emphasize that information-system performance emerges from coordinated quality attributes and supporting practices. Their analysis suggests that system reliability, information quality, service responsiveness, and operational control should be considered together when explaining why a digital platform performs effectively for its users.

The collective model is supported by the International Organization for Standardization (2023), which treats software and system quality as a multidimensional construct involving reliability, security, performance efficiency, compatibility, usability, and maintainability. These dimensions depend on integrated quality activities, thereby supporting an analytical approach in which several control practices jointly explain infrastructure performance.

Table 5: Regression coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	.446	.226		1.973	.051		
	Quality Inspection/ Testing	.353	.090	.329	3.922	.000	.340	2.937
	Quality Standards Compliance	.181	.078	.177	2.321	.023	.405	2.468
	Reporting	.271	.079	.283	3.430	.001	.350	2.861
	Corrective Action Implementation	.209	.065	.228	3.215	.002	.471	2.124

a. Dependent Variable: ICT Infrastructure Performance

Source: Field data, 2026

Table 5 indicates that the regression constant was positive (B = 0.446; t = 1.973; p = 0.051) but was not statistically significant at the 0.05 level. The intercept represents the expected baseline value of ICT Infrastructure Performance when all predictors are held at zero, a condition outside the practical Likert scale range. Its non-significance does not weaken the interpretation of the predictor effects because the substantive hypotheses concern the independent variables. The positive sign nevertheless maintained the required direction of the estimated baseline.

The tolerance values ranged from 0.340 to 0.471, and all were above the minimum acceptable threshold of 0.10, while the VIF values ranged from 2.124 to 2.937 and remained below the conservative threshold of 10. These results indicated that multicollinearity was not a serious problem among the predictors. Therefore, quality inspection/testing, quality standards compliance, reporting, and corrective implementation could be interpreted as distinct explanatory variables in the regression model.

Quality Inspection/Testing had a positive and significant effect on ICT Infrastructure Performance (B = 0.353; t = 3.922; p = 0.000). The coefficients show that a one-unit increase in Quality Inspection/Testing increased ICT Infrastructure Performance by 0.353 units when the other predictors were held constant. Since p was less than 0.05, the effect was statistically significant, and H01 was rejected. The tolerance value of 0.340 and VIF of 2.937 were within acceptable limits, indicating that multicollinearity did not distort this coefficient. The variable therefore made an independent contribution to the dependent variable in the Short Message Service Gateway project at Ishema Hub in Kigali City.

This relationship aligns with Wambua and Maake (2022), who explains that disciplined software quality assurance supports system dependability by detecting defects, validating functionality, and confirming readiness before operational use. Testing gives technical teams structured evidence for correcting weaknesses, reducing avoidable service interruptions, and protecting users from faults that could compromise the reliability or security of a digital platform.

Quality Standards Compliance had a positive and significant effect on ICT Infrastructure Performance (B = 0.181; t = 2.321; p = 0.023). The coefficient shows that a one-unit increase in Quality Standards Compliance increased ICT Infrastructure Performance by 0.181 units when the other predictors were held constant. Since p was less than 0.05, the effect was statistically significant, and H02 was rejected. The tolerance value of 0.405 and VIF of 2.468 were within acceptable limits, indicating that multicollinearity did not distort this coefficient. The variable therefore made an independent contribution to the dependent variable in the Short Message Service Gateway project at Ishema Hub in Kigali City.

This association resonates with Malega and Majerník (2024), whose work shows that standards and compliance procedures stabilize organizational processes by defining expected controls, responsibilities, records, and review mechanisms. Within technology services, consistent compliance supports secure access, controlled information handling, reliable operations, and accountability, thereby creating conditions in which infrastructure can deliver more predictable performance.

Reporting had a positive and significant effect on ICT Infrastructure Performance (B = 0.271; t = 3.430; p = 0.001). The coefficient shows that a one-unit increase in Reporting increased ICT Infrastructure Performance by 0.271 units when the other predictors were held constant. Since p was less than 0.05, the effect was statistically significant, and H03 was rejected. The tolerance value of 0.350 and VIF of 2.861 were within acceptable limits, indicating that multicollinearity did not distort this coefficient. The variable therefore made an independent contribution to the dependent variable in the Short Message Service Gateway project at Ishema Hub in Kigali City.

This relationship is supported by Atlassian (2024), which emphasizes that incident and performance reporting strengthens service management by converting operational events into shared evidence for response, learning, and improvement. Reports enable teams to coordinate decisions, trace recurring issues, communicate with users, and determine whether corrective measures have restored the expected service condition.

Corrective Action Implementation had a positive and significant effect on ICT Infrastructure Performance (B = 0.209; t = 3.215; p = 0.002). The coefficient shows that a one-unit increase in Corrective Action Implementation increased ICT Infrastructure Performance by 0.209 units when the other predictors were held constant. Since p was less than 0.05, the effect was statistically significant, and H04 was rejected. The tolerance value of 0.471 and VIF of 2.124 were within acceptable limits, indicating that multicollinearity did not distort this coefficient. The variable therefore made an independent contribution to the dependent variable in the Short Message Service Gateway project at Ishema Hub in Kigali City.

This result is consistent with Oueslati et al. (2024), who argue that defect-reduction planning becomes effective when organizations identify causes, select appropriate actions, implement changes, and verify whether recurrence has been reduced. Corrective processes therefore contribute to dependable systems by transforming technical problems into monitored improvements rather than allowing repeated faults to remain part of normal operations.

Therefore, all four predictors retained positive coefficients and statistically significant effects after simultaneous estimation. The collinearity statistics showed adequate tolerance and VIF values below commonly used concern thresholds, supporting the stability of the coefficient estimates. The regression evidence consequently supported the rejection of every null hypothesis and confirmed that each objective variable contributed independently to ICT Infrastructure Performance.

The adopted model for analysis was structured as follows:

$$Y = B0 + B1X1 + B2X2 + B3X3 + B4X4 + e$$

Where Y = ICT Infrastructure Performance; X1 = Quality Inspection/Testing; X2 = Quality Standards Compliance; X3 = Reporting; X4 = Corrective Action Implementation; B0 = constant; B1 to B4 = regression coefficients; and e = error term.

ICT Infrastructure Performance = 0.446 + 0.353 Quality Inspection/Testing + 0.181 Quality Standards Compliance + 0.271 Reporting + 0.209 Corrective Action Implementation + e

4.3 Decision on Null Hypotheses

This section consolidates the statistical decisions reached for the four null hypotheses. Each decision was based on the predictor significance value in the multiple regression model, using 0.05 as the criterion for determining whether the corresponding independent variable had a significant effect on ICT Infrastructure Performance.

Table 6: Decision on null hypotheses

Hypothesis	Null Hypothesis	Sig.	Decision
H01	Quality inspection/testing has no statistically significant effect on ICT infrastructure performance in SMS Gateway project at Ishema Hub.	.000	Rejected
H02	Quality standards compliance has no statistically significant effect on ICT infrastructure performance in SMS Gateway project at Ishema Hub.	.023	Rejected
H03	Reporting has no statistically significant effect on ICT infrastructure performance in SMS Gateway project at Ishema Hub.	.001	Rejected
H04	Corrective action implementation has no statistically significant effect on ICT infrastructure performance in SMS Gateway project at Ishema Hub.	.002	Rejected

Source: Field data, 2026

Table 6 shows that all predictor significance values were below 0.05. Each null hypothesis was therefore rejected in favor of the conclusion that its corresponding independent variable had a statistically significant effect on ict infrastructure performance. The decisions were consistent with the positive coefficients and the objective-specific correlation results. Taken together, the hypothesis tests confirmed that all four management dimensions were relevant explanatory factors in the Short Message Service Gateway project at Ishema Hub in Kigali City.

4.4 Discussion of Research Findings

4.4.1 Influence of Quality Inspection/Testing on ICT Infrastructure Performance

Quality inspection/testing had a positive and significant effect on ICT infrastructure performance (B=0.353, t=3.922, p=0.000). A one-unit increase in quality inspection/testing increased ICT infrastructure performance by 0.353 units when the other predictors were held constant. Since $p<0.05$, the effect was statistically significant. The collinearity indicators were within acceptable limits. Therefore, the first null hypothesis was rejected.

These findings align with Tariq (2025), who found that load testing, stress testing, endurance testing and spike testing supported platform reliability and user experience. The positive results in the current study similarly show that quality inspection/testing supported the performance of the SMS Gateway Project at Ishema Hub.

The outcomes resonate with Total Quality Management Theory, which holds that embedding quality in organisational processes improves performance and reduces defects (Lima et al., 2025). Systematic testing therefore supported system speed, platform availability, data security, message delivery reliability and service continuity.

4.4.2 Influence of Quality Standards Compliance on ICT Infrastructure Performance

Quality standards compliance had a positive and significant effect on ICT infrastructure performance (B=0.181, t=2.321, p=0.023). A one-unit increase in quality standards compliance increased ICT infrastructure performance by 0.181 units when the other predictors remained constant. Since $p<0.05$, the effect was statistically significant. The collinearity indicators remained within acceptable limits. Therefore, the second null hypothesis was rejected.

The findings align with Malega and Majerník (2024), who established that standardised compliance systems supported process quality, sustainability and management consistency. The positive results in the current study similarly indicate that compliance with security, service, documentation, access and data requirements supported ICT infrastructure performance.

The pattern resonates with Systems Theory, which views ICT infrastructure as a system of interrelated technologies, procedures, users and controls (Khasawneh & Dweiri, 2024). Compliance among these connected components supported coordinated operations and improved service outcomes in the SMS Gateway Project.

4.4.3 Influence of Reporting on ICT Infrastructure Performance

Reporting had a positive and significant effect on ICT infrastructure performance (B=0.271, t=3.430, p=0.001). A one-unit increase in reporting increased ICT infrastructure performance by 0.271 units after controlling for the other predictors. Since $p<0.05$, the effect was statistically significant. The collinearity

indicators were acceptable. Therefore, the third null hypothesis was rejected.

The findings align with Atlassian (2024), which reported that incident communication and reporting supported rapid response, service recovery and better visibility of technical problems. The favourable results in the current study similarly show that incident, downtime, test, compliance and performance reports supported ICT infrastructure performance.

The outcomes resonate with the Information Systems Success Model, which links system quality, information quality and service quality with user satisfaction and operational efficiency (Abdullah et al., 2024). Reporting provided information about technical events and supported performance decisions within the SMS Gateway Project.

4.4.4 Influence of Corrective Action Implementation on ICT Infrastructure Performance

Corrective action implementation had a positive and significant effect on ICT infrastructure performance (B=0.209, t=3.215, p=0.002). A one-unit increase in corrective action implementation increased ICT infrastructure performance by 0.209 units when the other predictors remained constant. Since $p<0.05$, the effect was statistically significant. The collinearity indicators remained within acceptable limits. Therefore, the fourth null hypothesis was rejected.

The findings align with Oueslati et al. (2024), who found that action-based defect-reduction planning supported software quality, fault correction and maintenance. The positive results in the current study similarly indicate that corrective action implementation supported ICT infrastructure performance in the SMS Gateway Project.

The findings resonate with Continuous Improvement Theory, which emphasises repeated planning, implementation, checking and adjustment to improve performance (Lima et al., 2025). Root cause analysis, fault correction, patch implementation, action tracking and preventive actions helped reduce recurring problems and maintain service continuity.

5. Conclusions and Recommendations

5.1 Conclusion

The study concluded that quality inspection/testing strengthened ICT infrastructure performance in the SMS Gateway Project at Ishema Hub by verifying message functions, detecting defects, assessing peak-load capacity, protecting data and confirming user requirements. Quality standards compliance reinforced security, service delivery, documentation, access control and data management across the platform.

Reporting converted incidents, downtime, testing, compliance and performance information into evidence for coordinating responses and making timely decisions. Corrective action implementation addressed recurring infrastructure failures through root cause analysis, fault correction, patches, action tracking and preventive measures. Together, these practices sustained platform availability, message delivery reliability, data security and service continuity.

5.2 Recommendations

This section presents recommendations derived from the study findings and conclusions. Suggestions for future research are also provided.

1. Ishema Hub management should establish a documented testing calendar covering test coverage, defect detection, load testing, security testing and acceptance testing before major system releases.
2. Software-development and quality-assurance teams should maintain realistic testing environments that reflect client integrations and peak messaging conditions.
3. Ishema Hub should maintain a compliance register covering security, service, documentation, access and data requirements, with responsibilities assigned to designated staff.
4. Technical and support teams should use standardised templates for incident, downtime, test, compliance and performance reports and review them regularly.
5. Ishema Hub should conduct root cause analysis for major or recurring incidents and maintain a corrective-action tracker showing responsibilities, deadlines, completion evidence and preventive measures.

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