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Strategies, Practices, and Challenges in Quality Assurance of Department of Public Works and Highways Horizontal Projects in the Third District of Quezon

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James B. Dancalan, ORCID No. 0009-0007-3438-2608

Department of Public Works and Highways, Quezon 3rd District Engineering Office, Poblacion, Catanauan, Quezon, Philippines

Abstract

Public infrastructure projects require consistent quality monitoring to ensure that construction outputs comply with technical standards, safety requirements, and government regulations. However, variations in implementation practices and compliance monitoring continue to affect project quality in local construction projects. In response, this study aimed to assess the existing QA strategies and practices applied in horizontal infrastructure projects and to identify the challenges encountered in their implementation. Specifically, the study sought to determine the respondents' profile in terms of age, gender, position and length of service; assess the extent of implementation of QA strategies and practices; identify the challenges encountered in QA implementation; determine significant differences in QA strategies when grouped according to profile variables; and propose an enhanced QA mechanism for project monitoring. Additionally, the study employed a descriptive quantitative research design to gather and analyze data from 47 engineers and 33 contractors directly involved in DPWH projects. Data collection was conducted using a structured and validated researcher-made survey questionnaire based on DPWH guidelines and ISO issuances. Data analysis involved frequency count and percentage, mean, and Kruskal-Wallis test. Findings revealed that majority of the respondents were middle-aged, male, project engineers with 11-20 years of experience. It was further revealed that quality assurance strategies in horizontal projects was effectively implement, including briefing, selection of projects for inspections, checking of project documents, actual inspection, exit dialogue, inspection and assessment reporting, and monitoring corrective actions. Also, the best practices, such as management responsibility, quality planning, resource management, process control, auditing, quality recording, and data analysis and reporting, were well implemented, yet challenges like deviations from specifications, lack of accountability, and inconsistent quality standards persist. Furthermore, significant differences in QA strategies were observed based on age, position, and length of service. The study recommends strengthening DPWH-LGU coordination, institutionalizing structured QA protocols, and enhancing contractor accountability, while integrating AI-driven analytics in the proposed enhanced mechanism.

Keywords: quality assurance (QA), horizontal infrastructure projects, DPWH guidelines, compliance monitoring, contractor accountability, AI-driven analytics

INTRODUCTION

Quality assurance (QA) in construction ensures that materials, processes, and outputs meet established safety and performance standards, supporting durable and compliant infrastructure delivery (Han et al., 2023; Juanzon & Muhi, 2019). It involves systematic planning, inspection, documentation, and supervision across all project stages to reduce defects and safeguard public welfare (Rinke et al., 2017; Zeng et al., 2022). Globally, QA frameworks draw heavily from ISO 9001 and related international standards, with highly regulated systems in Europe and North America and increasingly technology-driven approaches in advanced Asian countries such as Japan and Singapore (Ghansah & Edwards, 2024; Alawag et al., 2023). In contrast, developing nations continue to strengthen regulatory structures and adopt hybrid QA models as they transition toward more formalized quality systems (Rudwan et al., 2023).

In the Philippines, QA implementation is administered primarily by the Department of Public Works and Highways (DPWH), which prescribes standardized inspections, material testing, and field protocols to ensure that public works projects meet national safety and performance guidelines (Dando & Santillan, 2024). These mechanisms are reinforced by laws such as the National Building Code and the Government Procurement Reform Act, along with DPWH issuances emphasizing systematic briefings, document checks, inspections, and monitoring of corrective actions (DPWH, 2019). QA remains particularly important in areas like Quezon Province, where infrastructure must withstand frequent typhoons and geohazards, prompting close DPWH–LGU coordination and reviews tailored to local conditions (Rebistual, 2022).

Despite these frameworks, persistent challenges such as deviations from specifications, limited accountability, variable standards, and uneven access to training and technology—affect QA implementation at the project level (Liu et al., 2022; Rudwan et al., 2023). National initiatives such as "Build Better More" and DPWH's multi-year programming underscore the need for stronger site inspections, resource planning, and auditing practices to support resilient and long-term infrastructure (Patalinghug, 2023; DPWH, 2023). However, little is known about how QA strategies operate in specific local contexts, particularly in the Third District of Quezon, where engineers and contractors face unique environmental and capacity-related constraints. This gap necessitates empirical examination of existing QA strategies, practices, and challenges to develop enhanced mechanisms suited to the district's needs.

This specifically aimed to identify the profile of the respondents in terms of age, gender, position or designation, and length of service in the construction industry, determine the strategies and the practices utilized by the respondents in quality assurance in horizontal projects, as well as the challenges encountered by the respondents in implementing quality assurance in horizontal projects in the 3rd district of Quezon. This also assessed the significant difference in the strategies utilized in quality assurance mechanisms when the respondents are grouped according to profile. Lastly, this sought to propose enhanced quality control mechanisms based on the research findings.

LITERATURE REVIEW

This section provides a concise review of the strategies that guide the structured implementation of quality assurance in horizontal construction projects, the best practices that strengthen consistency and reliability in project execution, and the common challenges that hinder the effective and uniform application of QA across different project sites.

Strategies in Quality Assurance in Horizontal Projects. QA strategies in horizontal construction projects involve structured methods that ensure roads, bridges, and other public works comply with required standards throughout planning and implementation. Core approaches include lean construction practices, Total Quality Management principles, and digital innovations that support accuracy and reduce errors (Chung & Mutis, 2020; Liu et al., 2022). Flexible and well-structured QA systems help prevent delays, cost overruns, and quality failures, while poor or inconsistent practices weaken compliance and overall project performance (Luo et al., 2022).

In government projects such as those implemented by DPWH, QA strategies follow established protocols such as Department Order No. 132, grounded in systematic inspections, monitoring, and documentation to maintain policy adherence and structural durability (Dando & Santillan, 2024). Key strategies include briefing field officials to align teams with project expectations, selecting critical stages for inspection, rigorously checking project documents, and conducting on-site inspections to verify compliance. Studies show that these steps improve communication, reduce operational errors, and allow issues to be detected early before affecting project outcomes (Chung & Mutis, 2020; Liu et al., 2022).

Complementary strategies such as exit dialogues, inspection reporting, and monitoring corrective actions strengthen accountability and continuous improvement within QA processes. Detailed reporting helps track quality trends and guide informed decision-making, while consistent follow-up on corrective actions ensures that identified issues do not recur (Kirwan et al., 2022; Abdullahi et al., 2019). When these strategies are applied collectively, they form a comprehensive QA framework that supports safety, durability, and performance in horizontal infrastructure, reflecting a broader commitment to maintaining high construction standards across DPWH projects (Chung & Mutis, 2020).

Best Practices Utilized in Quality Assurance. Best practices in QA for horizontal construction projects center on a proactive and systematic approach that embeds quality into every phase of the project. Total Quality Management (TQM) encourages continuous improvement, early detection of defects, and shared responsibility among project stakeholders, which reduces rework, delays, and cost overruns (Jimoh et al., 2019). Digital tools such as Building Information Modeling (BIM) further strengthen QA by providing detailed project visualizations, enabling precise coordination, and supporting real-time monitoring of construction activities (Rolfsen et al., 2021). These are complemented by routine site inspections and audits that check compliance with standards and allow teams to correct deviations before they escalate (Abdullahi et al., 2019; Chung & Mutis, 2020).

In the Philippine public works context, the DPWH has institutionalized many of these practices through department orders that prescribe systematic briefings, inspections, document checks, and corrective action monitoring (Dando & Santillan, 2024). When benchmarked against ISO 9001, DPWH procedures align with key principles on documented processes, customer focus, and continual improvement, yet they can benefit from stronger integration of risk-based thinking and leadership-driven quality culture (ISO, 2015). International and regional frameworks, including Association of South-East Asian Nation (ASEAN) QA perspectives, also stress digital integration and sustainability, which suggests that DPWH systems should further expand their use of BIM, data analytics, and regional benchmarking to remain globally competitive (Chung & Mutis, 2020).

Within these frameworks, best practices commonly cluster around management responsibility, quality planning, resource management, process control, and auditing. Strong leadership commitment ensures clear quality policies, defined roles, and consistent enforcement of standards across all project stages (Abdullahi et al., 2019). Quality planning translates these commitments into concrete objectives, processes, and inspection plans, while effective resource management secures skilled personnel, reliable materials, and adequate funding to meet those objectives (Mohamed et al., 2019). Process control and formal audits then provide structured mechanisms for monitoring construction activities, checking materials and methods, and verifying that QA procedures are applied as intended (Rumane, 2019; Dando & Santillan, 2024).

Finally, best practices in QA place strong emphasis on quality recording and data-driven analysis. Reliable documentation of inspections, tests, and corrective actions supports transparency, traceability, and informed decision-making across the project lifecycle (Singh & Kumar, 2021; Bartek & Olsson, 2021). Recent studies show that digital tools, blockchain, and Industry 4.0 technologies enhance the security, accessibility, and analytical value of quality records, allowing agencies to detect patterns, anticipate failures, and refine their QA systems over time (Faraji et al., 2022; Saihi et al., 2023). In settings such as DPWH projects in the Third District of Quezon, these practices help ensure that roads, bridges, and other horizontal infrastructure are delivered with higher levels of safety, durability, and accountability, which strengthens public trust in government-funded construction (Nyakala et al., 2019; Chang et al., 2022).

Challenges Encountered in Implementing Quality Assurance. Challenges in implementing quality assurance (QA) in horizontal construction projects often stem from the complexity of construction processes, diverse stakeholder expectations, and inconsistent application of quality practices. Variability in QA procedures across project phases commonly leads to uneven outputs and rework, as seen in South African projects where weak standardization results in missed quality benchmarks and delays (Nyakala et al., 2019). Limited use of data analysis also hinders effective QA; without reliable real-time insights, defects may remain undetected until costly to correct, especially in projects that rely on technologies such as BIM and UAVs (Faraji et al., 2022). These issues demonstrate how gaps in QA systems can undermine efficiency, inflate costs, and compromise structural integrity.

Additionally, technological and organizational constraints further complicate QA implementation. The adoption of advanced tools often faces obstacles such as inadequate training, poor integration with existing systems, and inconsistent enforcement of standards, as observed in transportation agencies such as Missouri Department of Transportation (MoDOT) (Chang et al., 2022). Communication breakdowns also pose risks: when project teams and stakeholders fail to align expectations, misunderstandings delay corrective actions and weaken accountability (Lawani et al., 2023). Studies in various contexts report similar concerns, including the absence of qualified professionals, insufficient inspections, weak regulatory oversight, and reliance on informal or outdated QA mechanisms—all of which increase the likelihood of defects and structural deficiencies (Omollo, 2019; Egwunatum, 2022).

Generally, a broader set of systemic challenges also contributes to ineffective QA, such as weak management support, contractor performance issues, unrealistic timelines, poor material quality control, and fragmented communication systems (Bitew, 2019; Sin et al., 2024; Bartek & Olsson, 2021). Insufficient material testing, lack of QA units, and inadequate inspection frequency further exacerbate inconsistencies in quality control (Osegbo et al., 2021; Rouhanizadeh & Kermanshachi, 2020). Addressing these interconnected challenges requires standardized QA procedures, stronger data-driven monitoring, better integration of emerging technologies, resource optimization, and more transparent communication.

Conceptual Framework. The study adopted the Input–Process–Output (IPO) Model to illustrate the flow of concepts and procedures from data collection to the development of enhanced quality control mechanisms. The Input phase involved gathering respondent profiles, age, gender, position, and length of service, supported by Human Capital Theory, along with examining existing QA strategies and practices grounded in Total Quality Management, ISO 9001:2008 standards, DPWH protocols, and Benchmarking Theory, while identifying context-specific challenges aligned with Contingency Theory. The Process phase detailed the descriptive research design, including the study locale, 80 respondents, instrument development, validation, pilot testing, systematic data gathering, and statistical analyses such as frequency, percentage, mean, and the Kruskal–Wallis test.

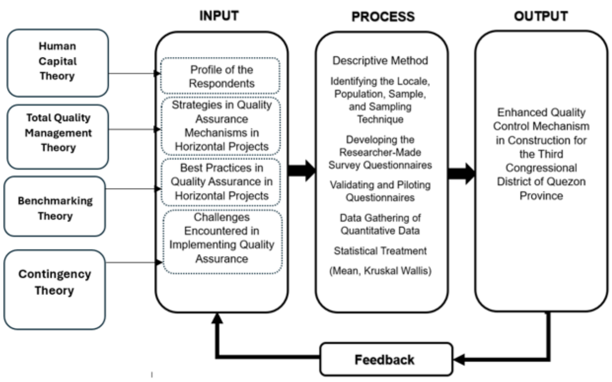

Figure 1
Research Paradigm

The Output phase produced an enhanced set of quality control mechanisms tailored to the conditions of the Third Congressional District of Quezon, supported by a feedback loop to refine and strengthen QA practices through continuous evaluation and improvement.

METHODS

Research Design. This study employed a descriptive quantitative research design to examine the strategies, best practices, and challenges in QA among engineers and contractors involved in DPWH horizontal projects in the Third District of Quezon. The design allowed the researcher to systematically describe current QA implementation practices and identify areas for improvement based on measurable data.

Population and Sampling. The study utilized a census approach. The entire population of 80 respondents was included, consisting of 47 engineers and 33 contractors directly involved in QA implementation. This approach ensured comprehensive representation of stakeholders engaged in DPWH horizontal projects within the district.

Instrumentation. Data were collected using a validated researcher-made questionnaire composed of four parts: (1) respondent profile, (2) QA strategies, (3) QA best practices, and (4) challenges encountered. The instrument underwent expert validation to ensure content accuracy and clarity. It was pilot tested with 30 participants, and reliability analysis produced acceptable Cronbach's alpha values ranging from 0.70 to 0.91, indicating good internal consistency.

Data Source. Primary data were gathered through the personally administered questionnaire. Ethical standards were strictly observed, including informed consent, voluntary participation, confidentiality, and secure handling of responses. Personal distribution of the instrument helped clarify questions and encouraged full participation.

Data Analysis. Descriptive statistics such as frequency, percentage, and mean were used to summarize respondent profiles and assess QA strategies, best practices, and challenges. The Kruskal-Wallis test was employed to determine significant differences in QA strategies across demographic variables such as age, gender, position, and years of service. This analytical procedure provided a structured basis for understanding QA implementation in the district and supported the formulation of enhanced quality control mechanisms.

RESULTS

This section presents and interprets the results of the study, beginning with the demographic profile of the respondents and followed by their assessments of quality assurance strategies, implemented best practices, and challenges in DPWH horizontal projects, as well as the statistical differences across groups and the development of the proposed "Joint Advanced Mechanism in Establishing Solid Horizontal Projects" or JAMES framework.

Table 1
Profile of the Respondents, (N = 80)

Profile Category	Classification	Frequency	Percentage (%)
Age	21-30 years old	11	13.75
	31-40 years old	35	43.75
	41-50 years old	16	20.00
	51-60 years old	12	15.00
	61 years old and above	6	7.50
Gender	Male	62	77.50
	Female	18	22.50
Position / Designation	Project Engineer	43	53.75
	Quality Assurance Personnel	21	26.25
	Contractor	16	20.00
Length of Service	1-2 years	1	1.25
	3-5 years	5	6.25
	6-10 years	16	20.00
	11-20 years	30	37.50
	21-30 years	18	22.50
	31 years and above	10	12.50

The profile of the 80 respondents in DPWH horizontal construction projects in the Third District of Quezon reflects a workforce dominated by middle-aged, highly experienced, and predominantly male professionals. The largest age group falls within 31–40 years old (43.75%), followed by those aged 41–50 (20.00%) and 51–60 (15.00%), indicating that most QA implementers are in their prime working years with substantial field exposure. Only 13.75% are 21–30 years old, and 7.50% are 61 years and above, showing limited participation of younger or senior professionals. This distribution suggests a stable workforce with moderate to extensive experience, likely contributing to consistent application of DPWH standards. The gender distribution reveals that 77.50% of respondents are male, reaffirming the longstanding male dominance in the construction sector, although the 22.50% female representation reflects increasing gender inclusion in QA roles. In terms of professional positions, more than half of the respondents are Project Engineers (53.75%), followed by QA personnel (26.25%) and contractors (20.00%), suggesting that QA responsibilities are heavily integrated into engineering functions rather than existing as an independent specialized unit. Finally, the length-of-service data shows that 60.00% of respondents have at least 11 years of experience, with the largest group serving 11–20 years (37.50%), while only 7.50% have below five years of experience, indicating a seasoned workforce with deep institutional knowledge.

Additionally, the concentration of respondents in the 31–50 age range suggests a workforce that blends technical maturity with adaptability to new practices, aligning with findings from Bhandari et al. (2019) who argue that middle-aged professionals demonstrate both practical competence and openness to innovation. Meanwhile, the dominance of male respondents mirrors global and local patterns of gender imbalance in construction, as noted in Dhamija et al. (2019), who emphasized that female underrepresentation could affect workplace inclusivity and limit diverse perspectives in QA decision-making. The small proportion of QA-designated personnel (26.25%) compared to Project Engineers (53.75%) suggests that QA is not yet fully institutionalized as an autonomous function within DPWH field operations. This supports Vo (2019), who observed that QA duties in developing countries are often merged with broader engineering roles, potentially causing role conflict and weaker monitoring. The high proportion of experienced personnel (length of service ≥11 years) reinforces Froese et al. (2019), who found that deep field experience enhances compliance with quality protocols and reduces construction errors. However, the minimal number of younger workers suggests limited succession planning and potential resistance to rapid digital transformation in QA, an issue similarly raised by Oni et al. (2019).

Moreover, the results suggest that there are both strengths and areas for improvement in QA systems within the district. A mature and experienced workforce strengthens the application of traditional DPWH field protocols and contributes to effective compliance with ISO-aligned standards. However, the scarcity of newer professionals may slow the adoption of emerging QA technologies such as BIM, drones, and AI-driven inspection systems. The gender imbalance indicates a need for more inclusive recruitment, capacity-building, and retention strategies that expand female participation in QA and engineering roles. The dominance of engineering roles in QA enforcement implies that DPWH may benefit from increasing specialized QA personnel to reduce role overload and enhance monitoring efficiency. The strong presence of long-tenured respondents suggests an opportunity to formalize mentorship programs where senior engineers transfer tacit QA knowledge to younger staff. Moreover, aligning local QA structures with ASEAN and ISO frameworks may encourage digital competency, innovation, and a more standardized QA environment.

The findings are consistent with Dhamija et al. (2019), the demographic profile shows that older and more experienced personnel contribute to stronger adherence to QA protocols, while fewer young workers limit the potential infusion of new skills. The results also mirror Bartek & Olsson (2021), who emphasized that seasoned professionals ensure consistent documentation and adherence to quality standards but may be less inclined toward adopting advanced technologies. Conversely, the study departs from contexts like those in Nyakala et al. (2019), where weak standardization was linked to low experience levels; in this case, a highly experienced workforce may buffer QA inconsistencies. However, the overreliance on middle-aged and senior workers may limit innovation and digital integration, a challenge highlighted by Faraji et al. (2022), who argue that modern QA systems require stronger data analysis and technological capacity. Overall, the demographic results indicate a strong foundation for QA in DPWH projects but underscore the need for greater diversification, youth engagement, and specialization to align with global best practices and strengthen future QA capacity.

Table 2
Respondents' Assessment of the Effective Strategies in Quality Assurance

Quality Assurance Strategy	Mean	Verbal Interpretation
Briefing field officials	4.13	Effective
Selection of project for inspection/assessment	4.09	Effective
Checking of project documents	4.33	Effective
Actual inspection	4.00	Effective
Exit dialogue	4.06	Effective
Inspection/assessment reporting	4.13	Effective
Monitoring of corrective actions	4.07	Effective
Grand Mean	**4.12**	**Effective**

Legend: 1.00–1.50 = Not Effective; 1.51–2.50 = Less Effective; 2.51–3.50 = Somewhat Effective; 3.51–4.50 = Effective; 4.51–5.00 = Highly Effective.

The results in Table 2 show that the seven major QA strategies used in DPWH horizontal construction projects, briefing field officials, project selection for inspection, document checking, actual inspection, exit dialogues, inspection reporting, and monitoring corrective actions, were all rated "Effective," with a general grand mean of 4.12. Among these, checking of project documents emerged as the strongest strategy (4.33), reflecting the sector's reliance on thorough document verification to ensure regulatory compliance and alignment with technical specifications. Actual inspection obtained the lowest mean (4.00), though still "Effective," suggesting consistent on-site oversight but also indicating potential variability in deviation tracking and inspection comprehensiveness. This pattern of results illustrates a quality assurance system that is structured, routine, and methodical, yet still evolving toward more rigorous and technology-enhanced practices.

The findings also reveal that QA strategies are implemented consistently across multiple stages of project execution, especially in communication and documentation, which scored high across several domains. Strategies such as conducting structured briefings, reviewing previous inspection reports, maintaining organized documentation, and using standardized inspection reports show that DPWH teams follow systematic protocols that strengthen compliance and reduce operational errors. However, certain aspects, such as post-briefing comprehension checks, risk-based inspection prioritization, and timely resolution of corrective actions, received comparatively lower (though still effective) ratings. These results imply that while procedural adherence is strong, mechanisms for real-time evaluation, risk forecasting, and rapid corrective action implementation may require further institutional reinforcement.

Findings imply the need for DPWH to enhance risk-driven QA processes, improve deviation tracking, and adopt digital tools to support timeliness and accuracy in reporting and monitoring. Strengthening risk assessment frameworks could ensure that resource-intensive inspections focus on projects with higher defect potential. Similarly, reinforcing systems for documenting new concerns during exit dialogues and ensuring timely resolution of corrective actions would help prevent recurring issues and minimize cost overruns. The results also support integrating digital platforms, such as electronic document management, mobile inspection applications, and real-time QA dashboards to streamline documentation, accelerate report submission, and improve oversight of corrective actions. Investing in continuous professional development would also reinforce the technical skills needed for emerging quality assurance technologies.

Furthermore, these findings align with and strengthen previously published studies, demonstrating that structured QA processes are most effective when supported by clear communication, documentation, and feedback mechanisms. The strong performance in briefing and reporting aligns with Chung and Mutis (2020) and Kim et al. (2020), who emphasized that clear communication reduces misunderstandings and enhances safety compliance. The high rating for documentation confirms the importance of document verification identified by Luo et al. (2022) and Tuhacek & Svoboda (2019). Meanwhile, the relatively lower ratings for deviation tracking and timely corrective actions parallel the gaps identified by Abdullahi et al. (2019) and Ahmed (2022), who noted that inspections must be coupled with consistent follow-up to ensure long-term quality improvement. Overall, the study contributes empirical evidence that DPWH's QA system is functional and structured but stands to benefit from deeper integration of risk assessment, digital tools, and follow-through mechanisms to achieve higher levels of construction quality and project reliability.

Findings on the best practices in quality assurance (Table 3) show that all seven domains are "Implemented", with a general grand mean of 3.83, indicating that QA implementation in DPWH horizontal projects is systematically practiced across management, technical, and documentation processes. Among the domains, "Auditing" ranks first (4.10), followed by "Management responsibility" (3.99) and "Quality recording" (3.97), which suggests that internal reviews, leadership commitment, and documentation are the strongest pillars of the QA system. "Process control" (3.82) also appears well embedded in operations, while "Resource management" (3.69), "Data analysis and reporting" (3.63), and "Quality planning" (3.62) lag slightly behind the others, although still within the "Implemented" range. These patterns indicate that the QA framework is functionally in place, but strategic planning, data-driven analysis, and resource optimization are not yet as mature as auditing and documentation functions.

Table 3
Practices of the Respondents in Quality Assurance Implementation

Dimension	Mean	Verbal Interpretation
Auditing	4.10	Implemented
Management responsibility	3.99	Implemented
Quality recording	3.97	Implemented
Process control	3.82	Implemented
Resource management	3.69	Implemented
Data analysis and reporting	3.63	Implemented
Quality planning	3.62	Implemented
Grand Mean	**3.83**	**Implemented**

Legend: 1.00–1.50 = Not Implemented; 1.51–2.50 = Less Implemented; 2.51–3.50 = Somewhat Implemented; 3.51–4.50 = Implemented; 4.51–5.00 = Highly Implemented.

Additionally, a closer look at the internal pattern of scores shows that management and auditing practices are strong at the policy and compliance level but weaker in feedback loops and advanced analytical tools. For example, management is rated highly for commitment and setting clear quality objectives, yet establishing structured feedback systems to refine QA practices receives the lowest rating within the domain. Likewise, in quality planning, respondents confirm that detailed quality plans, checkpoints, and standards are prepared, but risk management and contingency planning are only "Somewhat Implemented," hinting at a more reactive than proactive planning culture. In resource management, the workforce is adequately trained, and tools are generally available, yet monitoring resource allocation and tracking resource use through systems remains relatively weaker. Process control emphasizes documentation and standardized

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procedures, but statistical methods and digital tools for process variation analysis are not widely used. Similarly, quality recording is strong in accessibility and organization of records, but regular accuracy checks and documentation training need to be tightened. Finally, data analysis and reporting show that clear written reports are produced, although statistical analysis, trend identification, and visualizations (charts, graphs) are only "Somewhat Implemented," which limits the full potential of evidence-based decision-making.

Likewise, these results carry important implications for strengthening QA in DPWH horizontal projects. On one hand, the relatively high ratings for auditing, management responsibility, and quality recording indicate a solid compliance-oriented backbone: audits are regular, leaders are visibly committed, and documentation is comprehensive and accessible. On the other hand, the weaker areas, risk-based quality planning, resource tracking, statistical process control, and data visualization or analytics which point to a gap between "doing QA" and using QA strategically for prediction, prevention, and continuous improvement. To move from compliance to excellence, the District can: (1) institutionalize risk-based and contingency-focused quality planning, (2) deploy digital tools for resource tracking, process monitoring, and document management, (3) build capacity in statistical quality control and data analytics, and (4) formalize feedback and learning loops where results of audits, inspections, and performance data are regularly discussed and translated into specific process improvements. These enhancements are particularly important for aligning local practices with ISO-based QMS and for preparing the district to integrate Artificial Intelligence (AI)-driven and Industry 4.0 tools in the future.

Similarly, the pattern of strengths and gaps is consistent with findings from other construction contexts. The strong role of leadership and auditing echoes Abdullahi et al. (2019), who stressed that management commitment and structured audits are central drivers of QA implementation, and Ahmed (2022), who described auditing as a core requirement of ISO 9001-based systems. However, the relatively weaker attention to quality planning, risk management, and contingency measures mirrors the concerns raised by Bitew (2019) and Abdullahi et al. (2019), who reported that poor planning frameworks and limited awareness of quality management principles often hinder effective QA in road and building projects. Likewise, the limited use of statistical methods and digital tools in process control and data analysis aligns with observations by Liu et al. (2022), Oyewole and Mewomo (2022), and Chang et al. (2022), who argue that many agencies still rely on traditional inspection-based systems rather than data-driven, technology-enhanced QA frameworks.

Table 4
Challenges Encountered in Implementing Quality Assurance in Horizontal Projects

	Challenges	Mean	Rank
1	Variability in quality standards across different projects.	4.61	3
2	Lack of proper training for personnel on quality assurance practices.	8.04	10
3	Inadequate or incomplete documentation of quality control processes.	7.81	9
4	Limited resources, such as personnel or equipment, affect quality control.	6.51	7
5	Poor communication between stakeholders and project teams regarding quality expectations.	5.16	4.5
6	Delays in conducting inspections and assessments are impacting timely quality checks.	5.16	4.5
7	Deviations from project specifications and standards by contractors.	2.34	1
8	Insufficient accountability for quality issues among team members and contractors.	3.34	2
9	Poor implementation and monitoring of corrective actions for identified quality issues.	5.30	6
10	Insufficient or outdated tools and technology for effective quality control and monitoring.	6.30	8

Legend: 1 as the highest and 10 as the lowest

Table 4 depicts the respondents' assessment of the challenges encountered in implementing QA in DPWH horizontal construction projects. Based on the gathered data and the analysis of rankings, findings indicate that deviations from project specifications and standards by contractors emerged as the most significant challenge, with a mean score of 2.34 and ranked first. This suggests that contractors frequently fail to comply with established project requirements, leading to inconsistencies in construction quality. This issue could stem from inadequate contractor oversight, insufficient technical expertise, or cost-cutting measures that compromise adherence to quality standards.

Moreover, the second-ranked challenge is insufficient accountability for quality issues among team members and contractors, with a mean score of 3.34. This indicates that the lack of responsibility for quality control errors and failure to enforce corrective actions contribute to recurring project deficiencies. Weak accountability structures may arise from unclear role definitions, the absence of strong enforcement mechanisms, or lack of consequences for non-compliance. Additionally, the third-ranked challenge is variability in quality standards across different projects, which received a mean score of 4.61 (Rank 3). This finding highlights the inconsistencies in implementing quality protocols across various DPWH projects, leading to uneven construction quality levels. The differences may be due to region-specific regulations, contractor capabilities, or discrepancies in available resources and enforcement mechanisms.

Conversely, the lowest-ranked challenge is lack of proper training for personnel on quality assurance practices, with a mean score of 8.04 (Rank 10). While still a concern, this suggests that training initiatives are relatively in place but may require enhancement to ensure uniform application of QA standards across all levels of the workforce.

The findings indicate that the most critical challenges in implementing quality assurance in DPWH projects revolve around contractor compliance, accountability, and inconsistency in quality enforcement. The low adherence to project specifications by contractors suggests that gaps exist in regulatory enforcement, contractor oversight, and quality verification processes. Contractors may either intentionally bypass standards to cut costs or lack the necessary expertise to meet the required quality benchmarks. Moreover, the lack of accountability among contractors and project teams suggests a weak culture of responsibility, where errors and deficiencies are not adequately addressed. This could be due to lenient penalties for non-compliance, limited tracking of quality performance, or weak leadership in enforcing corrective measures. Additionally, the variability in quality standards across different projects further complicates the QA process. The inconsistency could be caused by differences in resource availability, project management approaches, or regional policy variations. These inconsistencies make it difficult to maintain uniform construction quality across all DPWH projects, potentially leading to structural deficiencies and safety risks. For the DPWH, these findings emphasize the urgent need to strengthen regulatory enforcement and contractor accountability mechanisms.

The study's findings are aligned with Omollo (2019) where key barriers to quality assurance in the construction sector, including insufficient inspections, non-compliance with regulatory permits, and unauthorized building occupations. The present study's finding that contractor deviations from project specifications ranked as the highest challenge supports Omollo's assertion that weak regulatory enforcement contributes to construction quality issues. Similarly, Egwunatum (2022) emphasized that inadequate machinery, communication breakdowns, and poor equipment maintenance hinder the implementation of TQM in construction projects. This relates to the present study's findings on insufficient accountability and variability in quality standards, as both suggest that weak communication and resource allocation issues contribute to quality inconsistencies. On the other hand, Bitew (2019) identified contractor performance issues, unrealistic deadlines, and absence of a structured quality management policy as significant challenges.

Table 5
Assessment of Significant Difference in Strategies Utilized in Quality Assurance Mechanisms when Grouped

Profile Variable	QA Strategy Area	Test Used	Significant Difference?	Where the Significant Differences Lie (Post Hoc)	Overall Interpretation
Age	Briefing Field Officials	Kruskal-Wallis	**Yes**	No pairwise sig. differences; highest ranks: 61+	Older workers value briefings more; consensus overall
General Interpretation (Age): Significant differences exist in all QA areas; older employees consistently rate QA strategies higher, mid-career lower, younger more analytical/tech driven.	Selection of Projects for Inspection	Kruskal-Wallis	**Yes**	21–30 vs 31–40; 21–30 vs 41–50; 41–50 vs 61+	Younger prefer data-driven selection; older rely on experience
	Checking of Project Documents	Kruskal-Wallis	**Yes**	21–30 vs 41–50; 41–50 vs 61+	Mid-career prioritize documentation the most
	Actual Inspection	Kruskal-Wallis	**Yes**	21–30 vs 41–50; 31–40 vs 41–50; 41–50 vs 61+	Older employees strongly emphasize inspections
	Exit Dialogue	Kruskal-Wallis	**Yes**	21–30 vs 41–50; 31–40 vs 41–50; 41–50 vs 61+	Senior employees value structured exit discussions
	Inspection/Assessment Reporting	Kruskal-Wallis	**Yes**	21–30 vs 41–50; 31–40 vs 41–50; 41–50 vs 61+	Older workers see documentation as essential
	Monitoring Corrective Actions	Kruskal-Wallis	**Yes**	Mostly significant toward 61+ group	Experience increases emphasis on corrective action monitoring
Gender	All QA Strategy Areas	Mann-Whitney U	**No differences**	None	QA perceptions do not differ by gender; QA roles are standardized
Position	All QA Areas	Kruskal-Wallis	**Yes**	Generally *Engineers & QA Personnel > Contractors*	Engineers/QA value procedural QA; contractors prioritize execution
Position (Post Hoc)	Briefing, Selection, Document Checking, Inspection, Exit Dialogue, Reporting, Corrective Actions	Dunn Test	**Significant in Engineer/QA vs Contractor pairs**	Contractors rate QA practices lowest, especially inspections & reporting	
Length of Service	All QA Areas	Kruskal-Wallis	**Yes**	Many differences: mainly **21–30 years** vs others	Mid-career employees consistently rank QA strategies lowest; early & late career highest
Length of Service (Post Hoc)	Actual Inspection, Exit Dialogue, Reporting	Dunn Test	Significant mostly for **21–30 years** vs 3–5, 6–10, or 31+	Mid-career shows decreased engagement in QA procedures	

Findings from the inferential analysis show clear and meaningful patterns in how different groups of respondents view QA strategies in DPWH horizontal projects. To begin with, age, position, and length of service all emerged as significant factors, while sex did not produce any significant differences across all QA domains. Across the seven strategy areas, briefing field officials, selection of projects for inspection, checking of documents, actual inspection, exit dialogue, inspection and assessment reporting, and monitoring of corrective actions, older employees, particularly those aged 61 and above, consistently gave higher ratings to QA practices. Project Engineers and Quality Assurance Personnel also rated QA strategies more favorably than Contractors, while employees with 21–30 years of service repeatedly ranked QA mechanisms lower than both newer and more senior staff. Taken together, these results suggest that experience and role in the project strongly shape how QA systems are perceived and practiced, while gender does not appear to influence attitudes toward quality assurance in this context.

Looking more closely at these trends, there appears to be a distinct "profile" of how QA is valued at different stages of one's career and in different positions. On one hand, senior employees and those with over 31 years of service tend to give the highest ratings to structured QA activities such as inspections, documentation, exit dialogue, and monitoring of corrective actions. Their long exposure to project cycles, non-compliance issues, and construction failures may explain why they attach great importance to systematic QA procedures. On the other hand, early-career employees, especially those with fewer than 10 years of service, also rate many QA strategies quite highly, which is understandable since they are still in a learning phase and are more likely to follow established protocols closely. In contrast, mid-career employees with 21–30 years of service consistently give lower ratings to key QA strategies, including inspections, exit dialogues, and reporting. This suggests that as responsibilities shift toward coordination, administration, and broader project oversight, direct engagement in hands-on QA practices may decrease. At the same time, the differences by position reveal that Project Engineers and QA Personnel see QA as central to their work, while Contractors appear more focused on getting the project built on time and within budget, sometimes treating QA activities as supporting paperwork rather than as a core management tool.

Likewise, from a practical standpoint, these patterns carry important implications for strengthening QA implementation in DPWH projects. For one, the relatively lower emphasis on inspections, exit dialogues, and detailed reporting among mid-career employees indicates a potential gap that may affect the consistency and depth of QA enforcement on site. Addressing this will require targeted interventions such as refresher training, mentoring from senior QA-focused personnel, and clearer integration of QA responsibilities into mid-career job descriptions. In addition, Contractors' lower ratings of actual inspections, exit dialogue, and inspection reporting suggest that QA has not yet been fully internalized as part of their core professional identity. Strengthening contract provisions, clarifying accountability for quality outcomes, and requiring active contractor participation in inspections and post-inspection discussions could help close this gap. Furthermore, the strong QA orientation of senior employees can be turned into an advantage by designing mentoring systems where they guide younger and mid-career staff in documentation, reporting, and corrective action monitoring. In this way, institutional knowledge is not only preserved but also transferred systematically across generations and positions.

Further, the results of this study are both affirming and revealing. On one side, the strong emphasis on structured QA among older and long-tenured employees supports the findings of Vo (2019), who observed that age and tenure tend to increase adherence to standards and deepen commitment to quality-focused routines. Similarly, Dhamija, Gupta, and Bag (2019) reported that seasoned workers often show higher job satisfaction and stronger engagement with established procedures, which aligns with the current finding that senior respondents consistently rate inspections, reporting, and corrective action monitoring highly. On the other side, the lower ratings given by mid-career employees challenge the view of Bitew (2019), who argued that mid-career professionals are usually the most engaged in QA due to their active involvement in project execution. Generally, the study confirms that QA practice is not only a matter of written policy but is strongly shaped by experience, role, and career stage, pointing to the need for differentiated yet integrated QA capacity-building across the DPWH workforce.

DISCUSSION

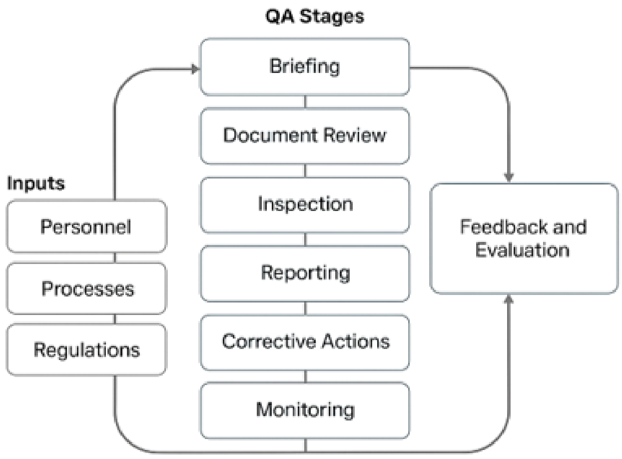

Figure 2
Enhanced Quality Control Mechanism Paradigm

The proposed JAMES Framework presents an improved, data-informed, and proactive framework for strengthening QA in DPWH horizontal projects. It builds on the study's findings by refining QA strategies, reinforcing best practices, and addressing persistent challenges in field operations, documentation, inspections, reporting, and corrective action monitoring. JAMES enhances existing processes by improving inspection prioritization, enforcing structured document reviews, strengthening exit dialogue documentation, expediting report submission, and tightening oversight of corrective actions. It also integrates modern digital tools such as AI for predicting defects, BIM for coordinated and error-reduced project modeling, and drone inspections for safer and more comprehensive field assessments. These technological enhancements, combined with e-QA systems, support more transparent QA implementation in alignment with DPWH standards.

In addition, JAMES fortifies best practices by reinforcing management accountability, quality planning, resource monitoring, process control, auditing, and quality recording. It addresses gaps in contingency planning, resource allocation, data validation, and auditor training, while promoting the use of visual data tools to improve reporting clarity. To resolve the major QA challenges identified in the study, such as deviations from standards, limited training, weak accountability, and inconsistent QA practices, JAMES introduces mechanisms like a Contractor Performance and Compliance Monitoring System, a mandatory QA Training and Certification Program, and a strengthened accountability framework that includes incentives and penalties. Its three-phase rollout, development, and digital integration, pilot implementation with capacity building, and full-scale institutionalization, to ensure that QA processes become more consistent, transparent, and evidence-based across all DPWH horizontal projects.

Conclusion. The study concludes that the workforce handling DPWH horizontal projects is predominantly composed of middle-aged male project engineers with extensive experience of 11–20 years, indicating a technically mature and field-seasoned QA environment. The strategies employed in briefing, inspection selection, document checking, site inspections, exit dialogues, reporting, and corrective action monitoring are consistently rated effective, showing that QA implementation is generally systematic and aligned with required standards. Moreover, best practices such as management responsibility, quality planning, resource allocation, process control, auditing, documentation, and data reporting are found to be well-implemented, reflecting a functional and organized QA system across projects.

Despite these strengths, the study also identifies persistent QA challenges, including deviations from project specifications, insufficient accountability among contractors and team members, and inconsistencies in quality standards across sites. Furthermore, significant differences in QA assessments based on age, position, and length of service suggest that professional background and field exposure influence how QA strategies are understood and applied. Finally, the study developed the JAMES model as an enhanced QA framework grounded in empirical strengths and areas needing improvement.

Recommendation. Based on the findings, the study recommends strengthening coordination between DPWH project engineers and LGU officials, while also providing targeted QA and leadership training for mid-career staff and expanding gender-inclusive initiatives. Institutionalizing structured briefings, standardized inspection checklists, and digitalized QA reporting is encouraged to improve consistency and accountability. Enhancing training on management responsibility, process control, and data-driven QA, including the adoption of AI-assisted auditing tools can further strengthen quality planning and analysis. Addressing major challenges such as contractor non-compliance and inconsistent standards requires stricter contractual enforcement, a contractor performance monitoring system, and mandatory QA certification for contractors. Since significant differences were found across age, position, and length of service, capacity-building should be tailored to each group, supported by stakeholder feedback systems and transparent QA reporting. Finally, the proposed JAMES mechanism should be refined through pilot testing, technological integration, and comparative evaluation across other DPWH districts to assess scalability and impact.

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