TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS

Thesis No:080/MSCoM/017

Implementation of QA/QC Measures in ADB-Funded GIS Substations in Kathmandu Valley: A Stakeholder Perception-Based Survey

by

Rabin Dhakal

A THESIS

SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN CONSTRUCTION MANAGEMENT

DEPARTMENT OF CIVIL ENGINEERING

LALITPUR, NEPAL

April, 2026

COPYRIGHT

The author has agreed that the library, Department of Civil Engineering, Pulchowk Campus, may make this thesis freely available for inspection. Moreover, the author has agreed that permission for extensive copying of this thesis for scholarly purpose may be granted by the Professors, who supervised the project work recorded herein or, in their absence, by the Head of the Department or concerning M.Sc Program Coordinator or dean of the Institute in which this thesis was done. It is understood that the recognition will be given to the author of this thesis and to the Department of Civil Engineering, Institute of Engineering, Pulchowk Campus in any use of the material of this thesis. Copying or publication or the other use of this thesis for financial gain without approval of the Department of Civil Engineering, Pulchowk Campus, Institute of Engineering and author's written permission is prohibited.

Request for permission to copy or to make any other use of the material in this thesis in whole or in part should be addresseed to:

....

Head

Department of Civil Engineering

Pulchowk Campus, Institute of Engineering

Pulchowk, Lalitpur

Lalitpur, Nepal

DECLARATION

I hereby declare that the thesis entitled "Implementation of QA/QC Measures in ADB-Funded GIS Substations in Kathmandu Valley: A Stakeholder Perception-Based Survey" submitted to the Department of Civil Engineering in partial fulfilment of the requirement for the degree of Master of Science in Construction Management, is a record of an original work done under the guidance of Assoc. Prof. Nagendra Bahadur Amatya and Assco .Prof Subash Kumar Bhattarai , Institute of Engineering, Pulchowk Campus. This thesis contains only work completed by me except for the consulted material which has been duly referenced and acknowledged.

Rabin Dhakal

080/MSCoM/017

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
PULCHOWK CAMPUS
DEPARTMENT OF CIVIL ENGINEERING

The undersigned certify that we have read, and recommended by the Institute of Engineering for acceptance, a thesis entitled "Implementation of QA/QC Measures in ADB-Funded GIS Substations in Kathmandu Valley: A Stakeholder Perception-Based Survey" submitted by Rabin Dhakal in partial fulfilment of the requirements for the degree of Master of Science in Construction Management.

Supervisor,
Asst. Prof.Subash Kumar Bhattarai
Department of Civil Engineering
IOE, Pulchowk Campus

Supervisor,
Assoc. Prof. Nagendra Bahadur Amatya
Department of Applied Science
and Chemical Engineering
IOE, Pulchowk Campus

External Examiner,
Assoc. Prof. Pramod Kumar Karmacharya
Msc.in Construction Management
Program Coordinator, Hillside
Engineering College, Balkumari Lalitpur

Program Coordinator,
Asst. Professor Mahendra Raj Dhital
M.Sc. in Construction Management
Department of Civil Engineering
IOE, Pulchowk Campus

ACKNOWLEDGEMENT

I would like to express my heartiest appreciation towards the Pulchowk Campus, Institute of Engineering, Tribhuvan University for providing me an opportunity to accomplish a graduation from this reputed institute. I am thankful towards the Department of Civil Engineering for providing me an opportunity to pursue this research.

I wish to express my deep gratitude and sincere thanks to my thesis supervisor, Asst. Prof. Subash Kumar Bhattarai and Assoc. Prof. Nagendra Bahadur Amatya for encouragement, inspiration, and thoughtful guidance during the course of this study.

I would also like to express my thanks to M. Sc.in Construction Management Faculty and Program Coordinator Asst. Prof. Mahendra Raj Dhital, Department of Civil Engineering for providing moral support and valuable feedback during thesis work.

Last but not the least, I am very grateful to my family and friends for their continuous encouragement and support, which motivated me to work harder and achieve my goal.

Rabin Dhakal

080/MSCoM/017

ABSTRACT

This study examines stakeholder perceptions regarding the implementation of Quality Assurance (QA) and Quality Control (QC) practices in Asian Development Bank (ADB)-funded Gas Insulated Substation (GIS) projects within Kathmandu Valley, Nepal. A mixed-method, perception-based approach was adopted. Primary data were collected through a structured questionnaire survey of 66 stakeholders, including client representatives (NEA, n=12), consultants (n=20), and contractors (n=34). Data were analyzed using descriptive statistics, Relative Importance Index (RII), and Pearson correlation analysis. Stakeholders perceived QA/QC implementation as moderate to good (mean scores 3.70–4.15). Field Quality Plan (FQP) implementation was strongest (mean = 4.15, SD = 0.36), while Inspection and Test Plan (ITP) implementation was weakest (mean = 3.70, SD = 0.93). A notable perception gap was observed: 67% of NEA respondents disagreed that ITPs are followed, whereas all contractor respondents agreed. RII analysis ranked weak monitoring and supervision (RII = 0.82) as the most critical barrier, followed by lack of skilled QA/QC personnel (RII = 0.79), poor documentation practices (RII = 0.76), and coordination gaps among stakeholders (RII = 0.74). Correlation analysis revealed that stakeholders perceived the strongest relationship between QA/QC implementation and rework reduction (r = -0.65, p = 0.005). Moderate relationships were observed with construction progress (r = 0.58), cost overrun (r = -0.60), and project delay (r = -0.55), though these were not statistically significant at the 95% confidence level. This study contributes to the limited body of perception-based research on QA/QC implementation in ADB-funded GIS substation projects in Nepal. The findings provide stakeholder-informed priorities for intervention, which can guide ADB, NEA, consultants, and contractors in strengthening QA/QC practices in future infrastructure projects.

Keywords: QA/QC, stakeholder perception, GIS substation, ADB projects, construction quality, Kathmandu Valley, RII analysis, correlation analysis

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

%	Percentage
ADB	Asian Development Bank
kV	Kilovolt
GIS	Gas Insulated Substation
QA	Quality Assurance
QC	Quality Control
NEA	Nepal Electricity Authority
ITP	Inspection Test Plan
DUDBC	Department of Urban Development and Building Construction
FQP	Field Quality Plan
PDCA	Plan Do Check Act
RQ	Research Question
SF6	Sulfur Hexafluoride
IEEE	Institute of Electrical and Electronics Engineers
FAT	Factory Acceptance Test
SAT	Site Acceptance Test
IEC	International Electrotechincal Commission
ISO	International Organization for Standardization
HGIS	Hybrid Gas Insulated Substation
PSC	Project Supervision Consultant
SASEC	South Asian Subregional Economic Cooperation
NCR	Non-Compliance Report
RII	Relative Important Index
BBS	Bar Bending Schedule
IR	Inspections Report

CHAPTER 1: INTRODUCTION

1.1 Background

The construction industry plays a vital role in the economic development of Nepal, particularly in the expansion of power infrastructure. In recent years, Nepal has made significant investments in high-voltage substations, including Gas Insulated Substations (GIS), to meet increasing electricity demand and strengthen the transmission and distribution network. GIS technology is preferred in urban areas like Kathmandu Valley due to its compact design, reliability, and enhanced safety features.

International funding agencies, particularly the Asian Development Bank (ADB), have been actively involved in financing and monitoring major power sector projects in Nepal. ADB-funded projects are governed by strict guidelines, standards, and procedures to ensure quality, sustainability, and accountability. These projects require the implementation of robust Quality Assurance (QA) and Quality Control (QC) systems throughout the project lifecycle—from design and procurement to construction and commissioning.

Quality Assurance refers to the planned and systematic activities implemented to ensure that quality requirements are fulfilled, while Quality Control involves the operational techniques used to verify that constructed works meet specified standards. In GIS substations—where precision, safety, and reliability are paramount—effective QA/QC implementation is essential to prevent defects, minimize rework, and ensure long-term performance.

However, the effectiveness of QA/QC systems depends not only on the existence of plans and procedures but also on how they are perceived and implemented by the stakeholders involved. Understanding stakeholder perspectives clients, consultants, and contractors provides valuable insight into the practical realities of QA/QC implementation. This study adopts a perception-based approach to examine how QA/QC measures are implemented in ADB-funded GIS substations within Kathmandu Valley.

1.2 Problem Statement

The Nepal Electricity Authority (NEA), in partnership with the Asian Development Bank (ADB), has invested substantially in GIS substation projects across Kathmandu Valley, including Lapshiphedi, Changunarayan, Teku, Thimi, Chobhar, and Futung. These projects are contractually required to follow defined QA/QC frameworks, including Quality Assurance Plans (QAP), Field Quality Plans (FQP), and Inspection and Test Plans (ITP).

Existing project documentation confirms that QA/QC plans are prepared and approved for these substations. Contractors, consultants, and NEA officials are aware of the required procedures. International standards (IEC, IEEE) and ADB guidelines provide clear technical specifications.

Despite the presence of these frameworks, there is limited systematic documentation of how stakeholders actually experience and perceive QA/QC implementation at the field level. Questions remain about:

- How consistently QA/QC procedures are applied across different activities and sites
- What barriers stakeholders encounter when trying to follow approved plans
- How stakeholders perceive the relationship between QA/QC efforts and project outcomes

Understanding stakeholder perceptions is valuable because QA/QC systems are implemented by people site engineers, inspectors, supervisors, and managers. Their experiences, challenges, and views influence how quality management functions in practice. Without capturing these perspectives, it is difficult to identify where QA/QC systems are working well and where they could be strengthened.

Previous studies in Nepal have examined technical aspects of GIS substations or general construction quality. However, limited research has systematically captured stakeholder perceptions of QA/QC implementation specifically in ADB-funded GIS projects within Kathmandu Valley.

This research seeks to document and analyze stakeholder perceptions of QA/QC implementation identifying what is working, what challenges are perceived, and what opportunities for improvement exist from the viewpoint of those directly involved in these projects.

1.3 Research Questions

- How do stakeholders perceive the current level of QA/QC implementation (including Field Quality Plans) in ADB-funded GIS substations within Kathmandu Valley?
- What do stakeholders identify as the major challenges and gaps affecting effective QA/QC implementation at the field level?
- How do stakeholders perceive the relationship between QA/QC implementation and project performance (rework, progress, cost, and schedule)?

1.4 Research Objectives

The main objective of this study is to analyze stakeholder perceptions of Quality Assurance and Quality Control (QA/QC) implementation in ADB-funded GIS substation projects within Kathmandu Valley.

The specific objectives are:

- To assess stakeholder perceptions of the current status of QA/QC implementation (including Field Quality Plans) in ADB-funded GIS substations within Kathmandu Valley.
- To identify and rank, from a stakeholder perspective, the major challenges affecting QA/QC implementation at the field level.
- To evaluate stakeholder-perceived relationships between QA/QC implementation and project performance indicators (rework, construction progress, cost overrun, and project delay).

1.4 Significance of the Study

This study provides perception-based, empirical insights into the implementation of Quality Assurance and Quality Control (QA/QC) measures in high-voltage Gas Insulated Substation (GIS) projects funded by the Asian Development Bank (ADB) within Kathmandu Valley. The findings are expected to be useful for multiple stakeholders. For the Nepal Electricity Authority (NEA), the study offers a structured understanding of how consultants, contractors, and internal staff perceive QA/QC practices, which can inform future project monitoring and quality management systems. For the Asian Development Bank (ADB) and other development partners, the perception-based findings highlight areas where technical assistance or capacity building may be most valuable for strengthening field-level QA/QC implementation. For consultants and contractors directly involved in substation construction, the study identifies priority areas based on stakeholder feedback for improving site-level quality practices, including supervision, documentation, and coordination. Finally, for researchers and postgraduate students, this study contributes to the limited body of literature on perception-based quality assessment in the context of ADB-funded power infrastructure projects in developing countries, serving as a reference for future studies in construction quality management.

1.6 Study Scope and Limitations

Scope

The scope of this study is limited to the implementation of Quality Assurance and Quality Control (QA/QC) measures in six Asian Development Bank (ADB)-funded Gas Insulated Substation (GIS) projects located within Kathmandu Valley, Nepal. These substations include Lapshiphedi, Changunarayan, Teku, Thimi, Chobhar, and Futung. The study focuses specifically on stakeholder perceptions of QA/QC practices during the construction and installation phases, including the implementation of Field Quality Plans (FQP), Inspection and Test Plans (ITP), material testing, site inspections, documentation practices, and compliance with ADB and NEA standards. Data were collected from three stakeholder groups directly involved in these projects: client representatives (NEA), consultants, and contractors. The study does not extend to operational or maintenance phases of the substations, nor does it cover non-ADB funded projects or substations outside Kathmandu Valley.

Limitations

This study has several limitations that readers should consider when interpreting the findings.

- First, the study is purely perception-based. The findings reflect the opinions, experiences, and views of 66 stakeholders who participated in the questionnaire survey. No independent, objective compliance audits or third-party measurements of QA/QC performance were conducted to verify or cross-check stakeholder perceptions.

- Second, the study did not include independent field observation data as core evidence. While site visits were conducted for contextual understanding, systematic field observation data were not collected or analyzed as part of the core results.
- Third, the geographical scope is limited to Kathmandu Valley. The findings may not be fully generalizable to other regions of Nepal.
- Fourth, the sample size of 66 respondents is relatively modest. While statistically adequate, a larger sample could provide additional insights.
- Fifth, the study focuses exclusively on ADB-funded projects. Findings may differ for projects funded by other agencies or domestic financing.
- Sixth, the study employs a cross-sectional design. Perceptions were captured at a single point in time and do not track changes over the project lifecycle.
- Seventh, self-reporting bias may be present. Respondents, particularly contractor representatives, may have been influenced by social desirability or organizational loyalty.

CHAPTER 2: LITERATURE REVIEW

2.1 Conceptual Framework of Quality Assurance and Quality Control in High-Voltage Infrastructure

Quality Assurance (QA) is defined as the systematic, proactive set of processes and organizational procedures designed to provide confidence that a product or service will consistently meet or exceed specified requirements. It focuses primarily on defect prevention through detailed planning, documentation, standardised procedures, and management systems. In contrast, Quality Control (QC) comprises the reactive, operational techniques including inspection, testing, measurement, verification, and monitoring that are applied to confirm that the established requirements have actually been fulfilled (Asian Development Bank, 2017; Quacci, 2017).

In the context of high-voltage Gas Insulated Substations (GIS), QA/QC frameworks are structured around the Plan-Do-Check-Act (PDCA) cycle. This cycle integrates risk-based thinking, complete traceability of materials and components, non-conformance identification and reporting, and timely corrective and preventive actions. These elements are particularly vital in GIS projects because even minor defects in critical components such as insulating basins, SF_6 gas seals, epoxy resin parts, or gas compartments can result in serious air-leakage faults, prolonged power outages, safety hazards for personnel, and substantial financial and reputational losses for the project (Liu et al., 2022).

Empirical studies on smart-grid and high-voltage components have consistently demonstrated that a well-structured, lifecycle-oriented QC approach significantly reduces long-term operational and maintenance costs by minimising equipment failures and enhancing overall system reliability (Quacci, 2017). Within the Nepali power sector, ADB-funded transmission and substation projects operate in a highly complex environment characterised by mountainous terrain, challenging logistics, community sensitivities, and seismic risks. In such settings, integrated QA/QC becomes not merely a contractual obligation but a strategic necessity for project success (Regmi et al., 2022). The conceptual framework adopted in this study therefore extends beyond pure technical compliance to encompass environmental safeguards most notably strict control of SF_6 gas leakage thereby aligning QA/QC practices with broader national and international sustainable development goals. This framework directly underpins the investigation of RQ1 (current implementation level), RQ2 (field-level challenges and gaps), and RQ3 (influence on project performance).

2.2 International Standards and Best Practices for GIS Substations

Gas Insulated Substation (GIS) technology, which uses SF_6 gas as the primary insulating medium within compact metal-enclosed modules, requires exceptionally rigorous QA/QC protocols to guarantee long-term reliability and safety. Two cornerstone international standards govern GIS design, manufacturing, testing, and installation:

- IEEE C37.122 (IEEE Standard for High Voltage Gas-Insulated Substations Rated Above 52 kV) provides comprehensive requirements for design reviews, Factory Acceptance Tests (FAT), Site Acceptance Tests (SAT), dielectric withstand testing, mechanical endurance tests, and gas tightness verification (Institute of Electrical and Electronics Engineers, 2021).
- IEC 62271-203 (High-Voltage Switchgear and Control gear – Part 203: Gas-Insulated Metal-Enclosed Switchgear for Rated Voltages Above 52 kV) specifies detailed criteria for insulation coordination, partial discharge measurement, internal arc classification, and strict SF_6 leakage limits (maximum 0.5 % per year per compartment) (International Electrotechnical Commission, 2022).

These standards are fully integrated with the ISO 9001 quality management system, which demands documented procedures, regular supplier audits, traceability of materials, and a culture of continual improvement. In practice, manufacturing QC relies heavily on routine tests (dielectric, mechanical, and gas purity) and type tests, while field erection and commissioning demand strict cleanliness protocols, precise alignment checks, controlled torqueing of joints, and carefully monitored SF_6 gas filling procedures (Liu et al., 2022).

Recent forensic investigations of actual field failures have highlighted the consequences of non-compliance. For instance, Liu et al. (2022) analysed a 500 kV HGIS grounding-knife-switch air-leakage incident and traced the root cause to incomplete epoxy resin curing combined with differential thermal expansion between the central copper conductor and the insulating material. Such cases demonstrate that adherence to these international standards is not optional but essential for preventing costly and dangerous defects. The standards therefore serve as the primary benchmark for evaluating the current level of QA/QC and Field Quality Plan (FQP) implementation at the Lapshiphedi GIS Substation (RQ1).

2.3 ADB's Requirements for QA/QC and Field Quality Plan in Nepal-Funded GIS Projects

The Asian Development Bank (ADB) enforces stringent QA/QC requirements through its Procurement Policy and Standard Bidding Documents for Plant contracts. Contractors are contractually obliged to prepare and implement a comprehensive Quality Assurance Plan (QAP) that covers the entire project lifecycle, supported by a detailed Field Quality Plan (FQP) specifically for on-site activities. Nepal Electricity Authority (NEA) and the appointed Project Supervision Consultants (PSC) exercise independent oversight, including document review, witnessing of critical FAT and SAT, stage-wise inspections, and enforcement of both technical and environmental safeguards (Asian Development Bank, 2017; Nepal Electricity Authority, 2019).

For the specific Khimti-Barhabise-Lapsiphedi 400/220/132 kV GIS project under the SASEC Power Transmission and Distribution System Strengthening Project (Loan 50059-003-NEP), the official bidding documents explicitly mandate submission of a contractor QAP and FQP, full material traceability, non-conformance management procedures, and regular verification by NEA and the PSC (Nepal Electricity Authority, 2019). These contractual provisions form the foundation for assessing how effectively QA/QC measures are being translated from paper into actual field practice at Lapshiphedi the central concern of RQ1. They also highlight the need to identify any systemic gaps between approved plans and on-site execution (RQ2).

2.4 Current Implementation, Challenges, and Gaps in Field-Level QA/QC

While ADB-funded projects in Nepal require robust QAPs and FQPs, literature and risk-mapping studies indicate that actual field-level implementation frequently encounters significant practical challenges. Regmi et al. (2022), in their detailed risk analysis of multiple ADB-supported high-voltage transmission and substation projects, applied an impact × frequency matrix and identified human factors, inadequate survey and background analysis, logistics difficulties, and terrain-related constraints as the highest-risk categories. These risks manifest directly in GIS erection activities, including handling of imported heavy GIS modules, shortage of skilled local technicians, adverse weather conditions in the Kathmandu Valley, and coordination issues among the contractor, NEA, and PSC teams.

Complementary evidence from fault analysis reinforces these concerns. Liu et al. (2022) documented how insufficient on-site monitoring of residual stress in insulating components led to air-leakage failures in similar high-voltage GIS equipment. Quacci (2017) further observed that gaps in field QC during installation and commissioning phases often result in higher rework rates, unplanned downtime, and schedule slippage.

2.5 Previous Studies on QA/QC Implementation Challenges

Multiple studies have examined challenges affecting QA/QC implementation in construction projects, both globally and in Nepal.

International Studies:

Abdul-Rahman et al. (2015) found that weak supervision and poor documentation were frequently cited as causes of quality issues in Malaysian construction projects. Love et al. (2016) reported that rework costs typically range from 5–15% of project cost, much of which is attributable to QA/QC gaps. Hoonakker et al. (2017) observed that projects with structured QA/QC systems showed 20–30% improvement in performance metrics. Tam et al. (2018) identified lack of contractor commitment and insufficient training as key barriers to quality plan implementation. Zeng et al. (2019) highlighted material quality and inspection delays as critical factors affecting construction quality.

Nepal-Specific Studies:

The Department of Urban Development and Building Construction (DUDBC, 2021) reported gaps in QA plan implementation in public building construction, particularly in documentation and monitoring. An NEA internal report (2022) identified delays in testing, lack of coordination, and weak enforcement of QA/QC procedures as recurrent observations in substation projects.

Shrestha et al. (2022) found that QA/QC implementation levels in Nepalese construction projects were moderate (mean ≈ 3.2/5), with major issues reported in supervision and training. Karki and Adhikari (2023), using RII analysis, identified poor documentation (RII = 0.78) and lack of skilled manpower (RII = 0.74) as top-ranked challenges.

Relevance to This Study:

These previous studies provide valuable context. However, most have focused on either general construction or transmission line projects, not specifically on GIS substations. Furthermore, few have adopted a perception-based approach that systematically captures stakeholder views across client, consultant, and contractor groups. This study builds on these earlier works by applying similar analytical methods (RII, correlation) to the specific context of ADB-funded GIS substations in Kathmandu Valley, while explicitly framing findings as stakeholder perceptions.

Table 1.Result from previous studies

S.N.	Author & Year	Study Area	Key Focus	Major Findings (Results)	Relevance to this study
1	Abdul-Rahman et al. (2015)	Malaysia	Quality Management in Construction	Found that weak supervision and poor documentation were the main causes of quality issues; RII > 0.75 for supervision-related factors	Similar issues in consultant supervision in substations
2	Love et al. (2016)	Australia	Rework in Construction Projects	Rework costs ranged from 5–15% of project cost due to poor QA/QC practices	Supports economic impact of poor QA/QC
3	Hoonakker et al. (2017)	USA	Quality Management Systems	Projects with structured QA/QC systems showed 20–30% improvement in performance	Justifies need for structured QA/QC in ADB projects
4	Tam et al. (2018)	Hong Kong	Implementation of Quality Plans	Identified lack of contractor commitment and training as key barriers	Matches contractor-side issues in Nepal
5	Zeng et al. (2019)	China	Construction Quality Control	Highlighted material quality and inspection delays as critical factors (RII > 0.80)	Directly relevant to material testing delays in substations

6	ADB (2020)	South Asia	Infrastructure Project Quality	Found that adherence to QA plans improves project sustainability and reduces defects significantly	Strong alignment with ADB-funded projects in your thesis
7	DUDBC (2021)	Nepal	Public Building Construction	Reported gaps in QA plan implementation, especially in documentation and monitoring	Direct Nepal context for your research
8	NEA Internal Report (2022)	Nepal	Substation Projects	Identified delays in testing, lack of coordination, and weak enforcement of QA/QC procedures	Highly relevant to GIS substation projects
9	Shrestha et al. (2022)	Nepal	Construction Project Performance	Found that QA/QC implementation level was moderate (mean ≈ 3.2/5) with major issues in supervision and training	Comparable baseline for your findings
10	Karki & Adhikari (2023)	Nepal	Quality Practices in Infrastructure	RII analysis showed top issues: poor documentation (0.78), lack of skilled manpower (0.74)	Supports your RII-based analysis

2.6 Influence of QA/QC Implementation on Project Quality, Cost, and Schedule Performance

The level of QA/QC implementation exerts a direct and measurable influence on overall project outcomes. Strong, proactive QC throughout the project lifecycle has been shown to reduce equipment failure rates and deliver substantial lifecycle cost savings (Quacci, 2017). Green construction site practices integrated within QA/QC such as effective energy and material management have produced tangible economic benefits, including up to 60 % reduction in water and energy consumption, productivity improvements of 1-25 %, and profit margin gains of at least 14 % (Chang et al., 2018; Gulghane et al., 2015; Zhang & Peng, 2017).

Conversely, weaknesses in field QA/QC frequently lead to cost overruns caused by rework, material wastage, or corrective actions, as well as schedule delays and potential contractual penalties related to SF_6 leakage or non-compliance. Regmi et al. (2022) demonstrated that unaddressed risks in early project phases significantly degrade both quality and schedule performance. These established relationships provide the theoretical and empirical foundation for RQ3, which seeks to quantify and qualify how QA/QC implementation at Lapshiphedi affects project quality, cost, and schedule, and to derive practical, context-specific improvement recommendations.

2.6 Perception-Based Studies in Construction Quality

Recent construction management research has increasingly recognized the value of stakeholder perception surveys as a method for assessing quality management systems. Unlike objective metrics—which measure what happened—perception-based studies capture how stakeholders experience and evaluate quality practices (Carvalho & Rabechini, 2017).

Perception-based approaches offer several advantages for QA/QC research. First, they reveal barriers that stakeholders actually encounter, rather than what compliance audits assume they encounter. Second, they capture variation in experiences across different stakeholder groups (clients vs. contractors vs. consultants). Third, they can identify misalignments between what management intends and what field staff perceives.

In the Nepalese context, Shrestha et al. (2022) and Karki & Adhikari (2023) have demonstrated that stakeholder perceptions often identify different priorities than compliance audits alone. For example, while audit findings may focus on documentation completeness, field staff may perceive supervision frequency or testing delays as more pressing concerns.

This study builds on this methodological tradition by focusing specifically on stakeholder perceptions of QA/QC implementation in ADB-funded GIS substation projects.

2.7 Research Gaps

Based on the reviewed literature, the following research gaps are identified:

Table 2.Research Gaps

Gap	Description
GIS-specific QA/QC studies in Nepal	Limited research has focused specifically on QA/QC implementation in GIS substation projects in Nepal. Most existing studies address general construction or transmission lines.
Perception-based approach	Few studies in the Nepalese power sector have systematically captured stakeholder perceptions across all three groups (client, consultant, contractor) using a structured, perception-based survey.
ADB-funded project focus	While ADB-funded projects follow stringent QA/QC requirements, limited research has examined how stakeholders perceive the implementation of these requirements at the field level.
RII and correlation application to GIS	RII ranking and correlation analysis have been applied to general construction quality in Nepal, but not specifically to GIS substation projects.

CHAPTER 3: METHODOLOGY

3.1 Research Design and Approach

This study adopts a descriptive and analytical research design with a mixed-method approach combining quantitative and qualitative data. The research is explicitly perception-based, meaning the primary data reflect the views, experiences, and opinions of stakeholders directly involved in QA/QC implementation, rather than objective third-party audits.

The rationale for this approach is threefold. First, perception-based research captures how stakeholders actually experience QA/QC systems, revealing barriers and enablers that compliance audits may miss. Second, it allows comparison of perspectives across different stakeholder groups (clients, consultants, contractors). Third, it aligns directly with the study's title and objectives, which focus on stakeholder perceptions.

The study is cross-sectional in nature, capturing perceptions at a single point in time during the construction and installation phases of the selected GIS substation projects.

The detail research methodology is presented in figure 1 below.

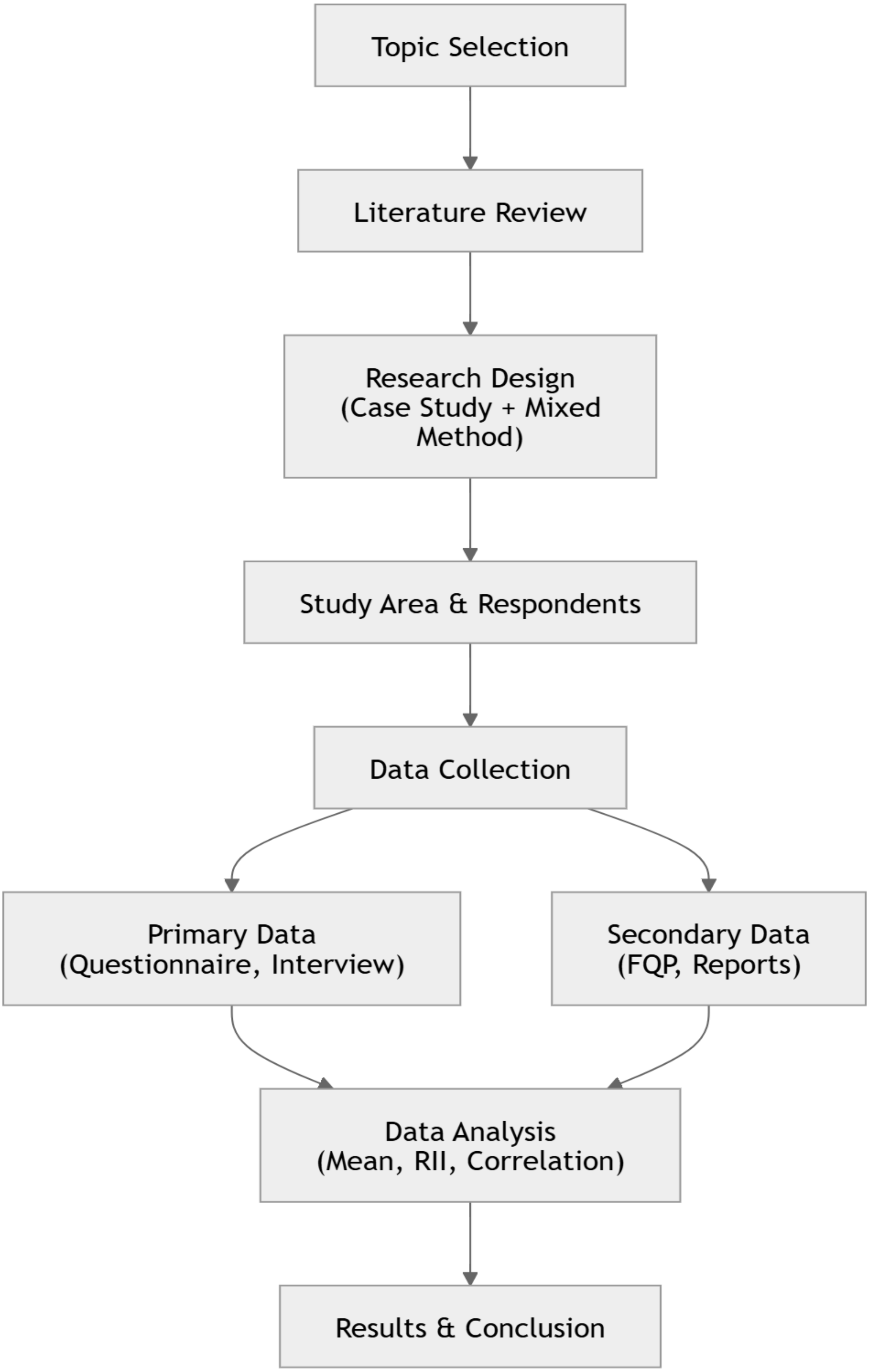

Figure 1: Research Methodology Flowchart

3.4 Study Area

The study was conducted within Kathmandu Valley, Nepal, which comprises three districts: Kathmandu, Lalitpur, and Bhaktapur. Kathmandu Valley was selected as the study area because it contains the highest concentration of ADB-funded GIS substation projects within a limited geographic region, allowing for comparative analysis across multiple sites. The six substations included in this study is presented in table 4 below.

Table 3. Study Projects

S.N.	Substation Name	Location
1	Lapshiphedi Substation	Northeastern Kathmandu Valley
2	Changunarayan Substation	Eastern Kathmandu Valley
3	Teku Substation	Central Kathmandu Valley
4	Thimi Substation	Eastern Kathmandu Valley
5	Chobhar Substation	Southern Kathmandu Valley
6	Futung Substation	Northern Kathmandu Valley

These substations are all 132 kV Gas Insulated Substations (GIS) funded by the Asian Development Bank (ADB) and implemented under the supervision of the Nepal Electricity Authority (NEA). The ongoing or recently completed nature of these projects provided an opportunity to assess real-time stakeholder perceptions of QA/QC practices.

3.3 Population, Sampling Technique, and Sample Size Determination

3.3.1 Study Population

The target population for this study consists of professionals and stakeholders directly involved in the construction, supervision, and quality management of ADB-funded GIS substation projects within Kathmandu Valley. The population of study is presented in table 5 below.

Table 4. Study Population

Stakeholder Group	Roles Included
Client (NEA)	Project managers, engineers, oversight officials
Consultant	Supervision consultants, QA/QC reviewers, design engineers
Contractor	Project managers, site engineers, QA/QC engineers, supervisors

The population is finite and specialized, as it includes only those professionals actively engaged in the selected six substation projects.

3.3.2 Sampling Technique

A purposive (judgmental) sampling technique was employed. This non-probability sampling method was selected because the study targets specific individuals who possess relevant knowledge, experience, and responsibility related to QA/QC practices. Only respondents directly involved in the selected projects were included.

The purposive approach ensured that:

- Respondents had direct, hands-on experience with QA/QC implementation
- All three stakeholder groups (client, consultant, contractor) were represented
- Responses were relevant to the specific context of ADB-funded GIS substations

3.3.3 Sample Size Determination

The sample size was determined using the statistical formula for an infinite population:

$$n = \frac{Z^2 \times p \times q}{e^2}$$

Where:

- n = required sample size
- Z = standard normal deviate at 90% confidence level (1.645)
- p = assumed proportion of success (0.50)
- $q = 1 - p$ (0.50)
- e = allowable error (0.10)

The calculated sample size was 68 respondents. However, due to field conditions and respondent availability, a total of 66 responses were collected and used for analysis. This slight variation does not significantly affect the reliability of the study, as the collected responses adequately represent the target population. The distribution of respondents is presented in table 6 below.

Table 5. Distribution of Respondents

Stakeholder Group	Target Sample	Actual Sample
Client (NEA)	13	12
Consultant	20	20
Contractor	35	34
Total	**68**	**66**

The higher proportion of contractor respondents reflects that contractors are directly involved in day-to-day construction activities and QA/QC implementation, while consultant and client respondents provide supervisory and monitoring perspectives.

3.4 Methods of Data Collection

Both **primary** and **secondary** data were collected for this study.

3.4.1 Primary Data

Primary data were collected through three methods:

A. Structured Questionnaire Survey

A structured questionnaire was developed and distributed to 66 respondents across the three stakeholder groups. The questionnaire was divided into five sections which is depicted in table 7 below.

Table 6. Content of Questionnaire Survey

Section	Content	Purpose
Section A	General information (organization, role, experience)	Demographic profiling
Section B	QA/QC & FQP implementation (5 questions)	Assess perceived implementation status (Objective 1)
Section C	Challenges in QA/QC implementation (6 questions)	Identify perceived barriers (Objective 2)
Section D	Impact on project performance (6 questions)	Evaluate perceived relationships (Objective 3)
Section E	Improvement measures (4 questions)	Gather recommendations

A five-point Likert scale was used:

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Neutral
- 4 = Agree
- 5 = Strongly Agree

A total of 8 key informant interviews were conducted. Interview notes were analyzed thematically to complement and contextualize the survey findings.

B. Field Observations

A structured checklist was used to observe QA/QC practices at each of the six substation sites. The checklist covered the parameter as mentioned in table 8 below.

Table 7. Parameters for Field Observation

Activity Area	Parameters Observed
Pre-construction	Drawing verification, site preparation
Material quality	Aggregates, cement, reinforcement steel, storage
Reinforcement works	Placement, cover, rust condition
Formwork	Alignment, bracing, surface condition
Concreting	Mixing, placing, compaction
Curing	Duration, method, coverage
Earthwork	Compaction, testing frequency
Masonry	Workmanship, material quality
Documentation	Checklist use, record keeping, NCR tracking

Field observation data were recorded as compliant or non-compliant based on standard specifications and were used to complement the perception-based survey data.

3.4.2 Secondary Data

Secondary data were collected from the following sources as mentioned in table 9 below.

Table 8. Parameters for Field Observation

Source	Type of Information
ADB procurement guidelines and policies	QA/QC contractual requirements
NEA project documents	Quality Assurance Plans, Field Quality Plans
Technical standards	IEC 62271-203, IEEE C37.122
Previous research studies	Journal articles, theses, reports
Contractor/submission documents	Inspection and Test Plans, test reports

Secondary data were used to establish the theoretical framework, understand contractual requirements, and contextualize primary findings.

3.5 Data Analysis Methods

Data analysis was conducted using descriptive statistics, Relative Importance Index (RII), and Pearson correlation analysis. Each analysis method corresponds to one of the three research objectives.

Analysis for Objective 1 (Perceived Implementation Status)

Method: Descriptive statistics (mean, standard deviation, frequency distribution)

Process:

- Questionnaire responses (Section B) were entered into SPSS/Excel
- Mean scores were calculated for each QA/QC variable
- Standard deviations were computed to assess response variability
- Results were presented in tables and figures

Interpretation Framework:

Mean Score Range	Perceived Implementation Level
1.00 – 1.80	Very Low
1.81 – 2.60	Low
2.61 – 3.40	Moderate
3.41 – 4.20	Good
4.21 – 5.00	Very Good

Analysis for Objective 2 (Perceived Challenges)

Method: Relative Importance Index (RII)

Formula:

$$RII = \frac{\sum W}{A \times N}$$

Where:

- $\sum W$ = Sum of weights assigned by all respondents
- A = Highest possible weight (5)
- N = Total number of respondents (66)

Process:

- Responses for challenge-related questions (Section C) were analyzed
- RII values (range 0 to 1) were calculated for each factor
- Factors were ranked from highest RII to lowest RII
- Higher RII indicates greater perceived importance as a barrier

Interpretation Framework:

RII Range	Perceived Importance
0.80 – 1.00	Very High
0.70 – 0.79	High

0.60 – 0.69	Moderate
0.50 – 0.59	Low
Below 0.50	Very Low

Analysis for Objective 3 (Perceived Performance Impact)

Method: Pearson Correlation Analysis

Formula:

$$r = \frac{\sum(X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum(X - \bar{X})^2 \sum(Y - \bar{Y})^2}}$$

Where:

- r = Pearson correlation coefficient
- X = QA/QC implementation score (independent variable)
- Y = Performance indicator score (dependent variable)
- $\bar{X}$ = Mean of X
- $\bar{Y}$ = Mean of Y

Process:

- QA/QC implementation scores (Section B) and performance impact scores (Section D) were correlated
- Correlation coefficients were calculated for each performance indicator
- Statistical significance (p-value) was assessed at 95% confidence level ($\alpha = 0.05$)

Interpretation Framework:

r Value Range	Strength of Relationship
0.00 – 0.19	Very weak
0.20 – 0.39	Weak
0.40 – 0.59	Moderate
0.60 – 0.79	Strong
0.80 – 1.00	Very strong

Note on Interpretation: Negative r values indicate inverse relationships (e.g., better QA/QC associated with less rework). Positive r values indicate direct relationships (e.g., better QA/QC associated with better progress).

Qualitative Data Analysis

Data from key informant interviews and field observation notes were analyzed using thematic analysis. The process involved:

1. Transcribing interview notes and observation records
2. Identifying recurring themes related to QA/QC implementation
3. Coding themes to correspond with the three research objectives
4. Using qualitative findings to complement and contextualize quantitative results

3.6 Reliability of the Study

3.6.1 Internal Consistency (Cronbach's Alpha)

The internal consistency of the questionnaire was assessed using Cronbach's Alpha coefficient. Reliability testing was performed on the survey responses to ensure that questionnaire items consistently measure the same underlying construct (stakeholder perceptions of QA/QC implementation).

The analysis yielded a Cronbach's Alpha value of 0.78, which is considered acceptable (above the minimum threshold of 0.70). This indicates that the questionnaire items are sufficiently correlated and reliably measure the intended construct.

Cronbach's Alpha Range	Reliability Level
≥ 0.90	Excellent
0.80 – 0.89	Good
0.70 – 0.79	Acceptable
0.60 – 0.69	Questionable
≤ 0.59	Poor

3.6.2 Content Validity (Expert Validation)

The questionnaire was validated by a panel of five experts with experience in:

- Construction management and QA/QC systems
- ADB-funded infrastructure projects
- GIS substation construction
- Academic research methodology

Experts evaluated each questionnaire item for:

- Relevance to research objectives
- Clarity of language
- Technical accuracy

- Suitability for different respondent groups

Based on expert feedback, revisions were made to rephrase unclear questions, remove redundant items, and add important QA/QC parameters that were initially missing.

3.6.3 Triangulation

To enhance the credibility of findings, methodological triangulation was employed:

- Survey data (quantitative) were compared with interview data (qualitative)
- Perception-based findings were compared with field observation records
- Primary data were compared with secondary document reviews

This triangulation allowed the study to identify convergence and divergence between what stakeholders perceive and what is observed or documented.

3.7 Research Matrix

The research matrix below tabulated in table 10 maps each research objective to its corresponding research question, data source, analysis method, and expected output.

Table 9. Research Matrix

Objective	**Data Source**	**Analysis Method**	**Expected Output**
To assess stakeholder perceptions of current QA/QC implementation status	Questionnaire (Section B), Field observations	Descriptive statistics (mean, SD, frequency)	Mean scores, standard deviations, tables, figures showing perceived implementation levels
To identify and rank perceived challenges affecting QA/QC implementation	Questionnaire (Section C)	Relative Importance Index (RII), Thematic analysis	RII values and rankings of challenges, interview themes
To evaluate perceived relationships between QA/QC and project performance	Questionnaire (Sections B & D), Project records	Pearson correlation, Thematic analysis	Correlation coefficients (r), p-values, significance levels, interpretation

CHAPTER 4: RESULTS AND DISCUSSION

This chapter presents the analysis and interpretation of data collected through stakeholder questionnaires, key informant interviews, and field observations. The chapter is organized according to the three research objectives. Section 4.2 presents field observation results, which provide complementary objective data on actual site conditions. Section 4.3 presents stakeholder perceptions of QA/QC implementation status (Objective 1), based on descriptive analysis of questionnaire responses. Section 4.4 presents stakeholder-identified challenges affecting QA/QC implementation (Objective 2), analyzed using Relative Importance Index (RII) and thematic analysis of interviews. Section 4.5 presents stakeholder-perceived relationships between QA/QC implementation and project performance (Objective 3), analyzed using Pearson correlation. Each section includes both results and discussion, with findings interpreted in the context of the literature reviewed in Chapter 2.

A total of 66 valid responses were analyzed, representing three stakeholder groups: client (NEA, n=12), consultant (n=20), and contractor (n=34). Field observations were conducted across all six substation sites using a structured checklist.

4.1 Stakeholder Perceptions of QA/QC Implementation Status

This section defines the results and discussions of objective 1 about Stakeholder Perceptions of QA/QC Implementation Status

4.1.1 Respondent Profile

A total of 66 respondents participated in the questionnaire survey. Table 11 presents the distribution of respondents by organization and role.

Table 10 Distribution of Respondents by Organization and Role

Organization	Engineer	Site Engineer	QA/QC Engineer	Project Manager	Other	Total
NEA (Client)	6	2	1	2	1	12
Consultant	8	4	4	3	1	20
Contractor	10	12	6	4	2	34
Total	**24**	**18**	**11**	**9**	**4**	**66**

Figure 2 illustrates the distribution of respondents by organization.

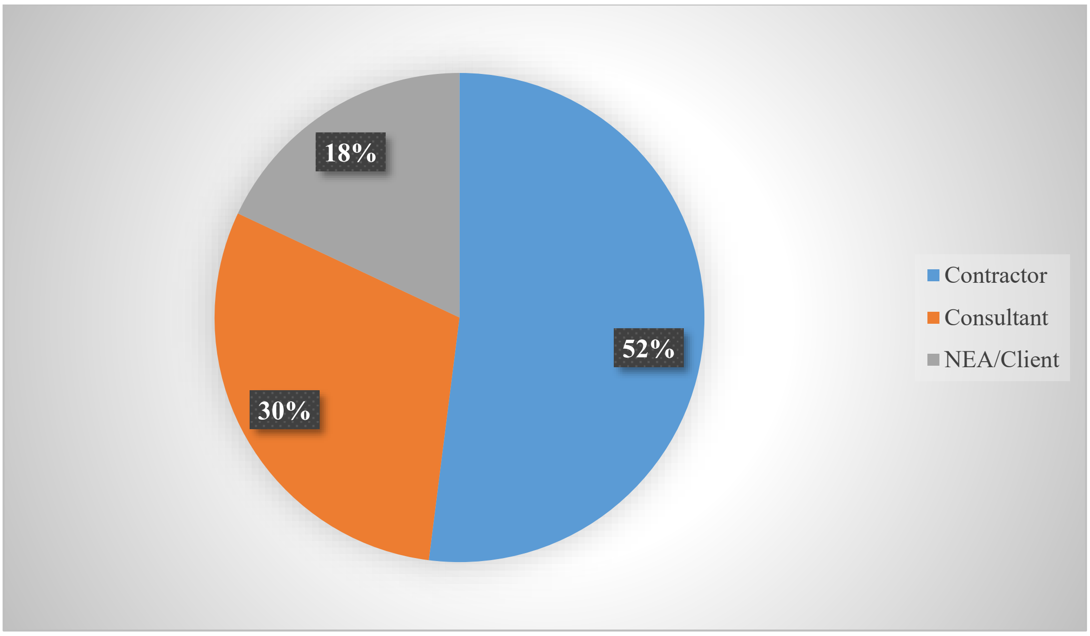

Figure 2: Respondent Distribution by Organization

The higher proportion of contractor respondents (52%) reflects that contractors are directly responsible for day-to-day construction activities and QA/QC implementation. Consultant (30%) and NEA (18%) respondents provide supervisory and monitoring perspectives. This distribution ensures that the perception data capture the views of those who implement QA/QC (contractors) as well as those who supervise and monitor it (consultants and NEA). Among the respondents, 24 are engineers, 18 are site engineers, 11 are QA/QC engineers, and 9 are project managers, indicating good representation of technical and managerial roles.

4.1.2 Perceived Implementation of Field Quality Plan (FQP)

Respondents were asked whether an approved Field Quality Plan (FQP) was available at their project site. Table 12 presents the responses.

Table 11: Stakeholder Perception of Approved FQP Availability at Site

Organization	Agree	Strongly Agree	Total
NEA (Client)	10	2	12
Consultant	18	2	20
Contractor	28	6	34
Total	**56**	**10**	**66**

Figure 3 illustrates the perceived FQP implementation status.

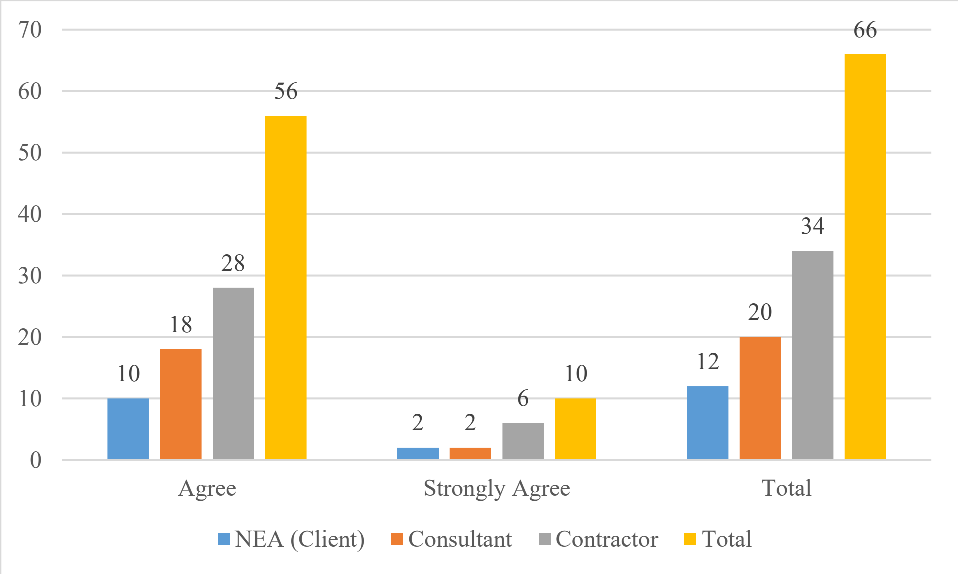

Figure 3: Stakeholder Perception of FQP Implementation

All 66 respondents either agreed (85%) or strongly agreed (15%) that an approved FQP is available at their site. The mean score for FQP implementation is 4.15 (between Agree and Strongly Agree), with a low standard deviation of 0.36, indicating high consistency across respondents. This finding confirms that from the stakeholder perspective, the planning and documentation phase of QA/QC is well established in ADB-funded GIS substations. This aligns with ADB requirements (Asian Development Bank, 2017) and NEA contract provisions (Nepal Electricity Authority, 2019), which mandate FQP submission before construction begins.

4.1.4 Perceived Implementation of Inspection and Test Plan (ITP)

Table 13 presents stakeholder perceptions of whether Inspection and Test Plans (ITPs) are clearly defined and followed.

Table 12: Stakeholder Perception of ITP Implementation

Organization	Disagree	Neutral	Agree	Strongly Agree	Total
NEA (Client)	8	2	2	0	12
Consultant	5	0	11	4	20
Contractor	0	0	30	4	34
Total	**13**	**2**	**43**	**8**	**66**

Figure 4 illustrates the perceived ITP implementation status.

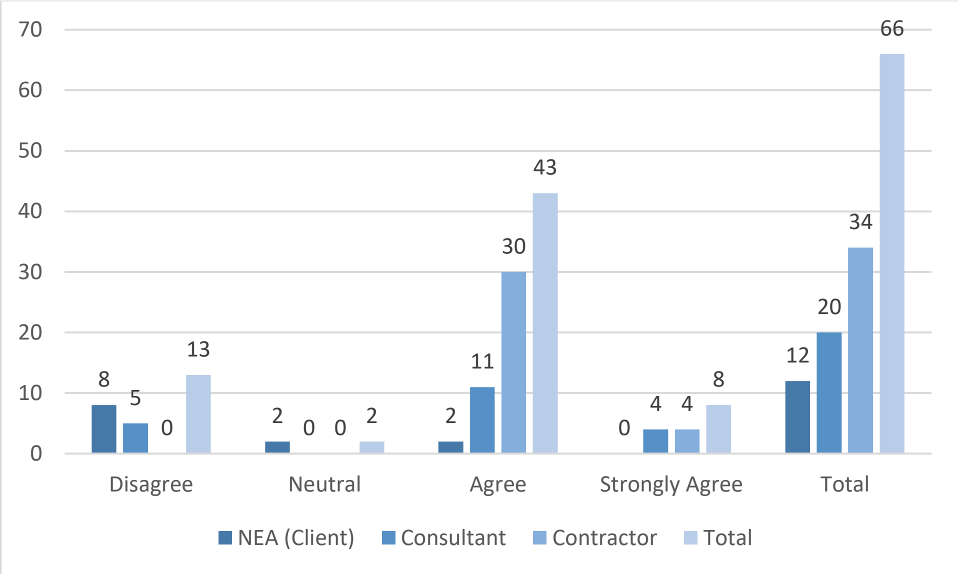

Figure 4: **Stakeholder Perception of ITP Implementation**

The mean score for ITP implementation is 3.70 (between Neutral and Agree), with a standard deviation of 0.93, indicating moderate variability in responses. Notably, 8 out of 12 NEA respondents (67%) disagreed that ITPs are clearly defined and followed, while all contractor respondents agreed or strongly agreed. This divergence in perception is a key finding. It suggests that while contractors believe ITPs are being followed, client representatives perceive gaps in ITP implementation. This perception gap may arise from different interpretations of "following ITPs" or different standards of compliance. Similar perception gaps have been documented by Karki and Adhikari (2023) in Nepalese infrastructure projects.

4.1.5 Perceived Material Inspection and Testing Practices

Table 14 presents stakeholder perceptions of material inspection and testing practices.

Table 13: Stakeholder Perception of Material Inspection and Testing

Organization	Disagree	Neutral	Agree	Strongly Agree	Total
NEA (Client)	4	2	6	0	12
Consultant	2	0	16	2	20
Contractor	0	0	16	18	34
Total	**6**	**2**	**38**	**20**	**66**

Figure 5 illustrates the perceived material testing practices.

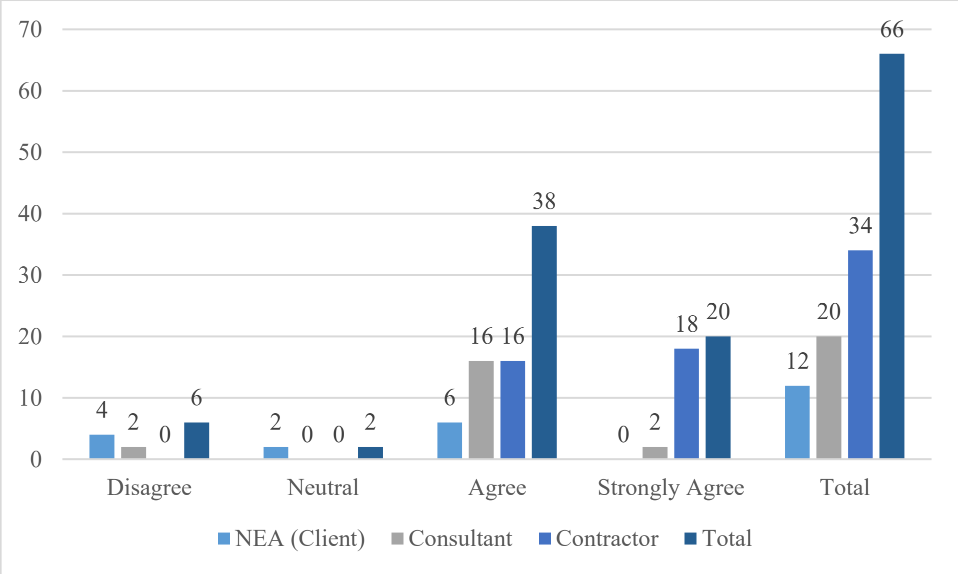

Figure 5: Stakeholder Perception of Material Inspection and Testing

The mean score for material inspection and testing is 4.09 (between Agree and Strongly Agree), with a standard deviation of 0.84, indicating relatively consistent positive perceptions. This finding aligns with the field observation data, where material-related activities (except aggregates quality) showed moderate to good compliance. Stakeholders across all three groups generally agree that construction materials are tested and verified in accordance with specifications. This perception is consistent with Zeng et al. (2019), who found that material testing is often the most structured QC activity in large infrastructure projects.

4.1.6 Perceived Site Inspection Frequency

Table 15 presents stakeholder perceptions of site inspection frequency.

Table 14: **Stakeholder Perception of Site Inspection Frequency**

Organization	Disagree	Neutral	Agree	Strongly Agree	Total
NEA (Client)	0	0	10	2	12
Consultant	3	4	10	3	20
Contractor	2	0	19	13	34
Total	**5**	**4**	**39**	**18**	**66**

Figure 6 illustrates the perceived site inspection frequency.

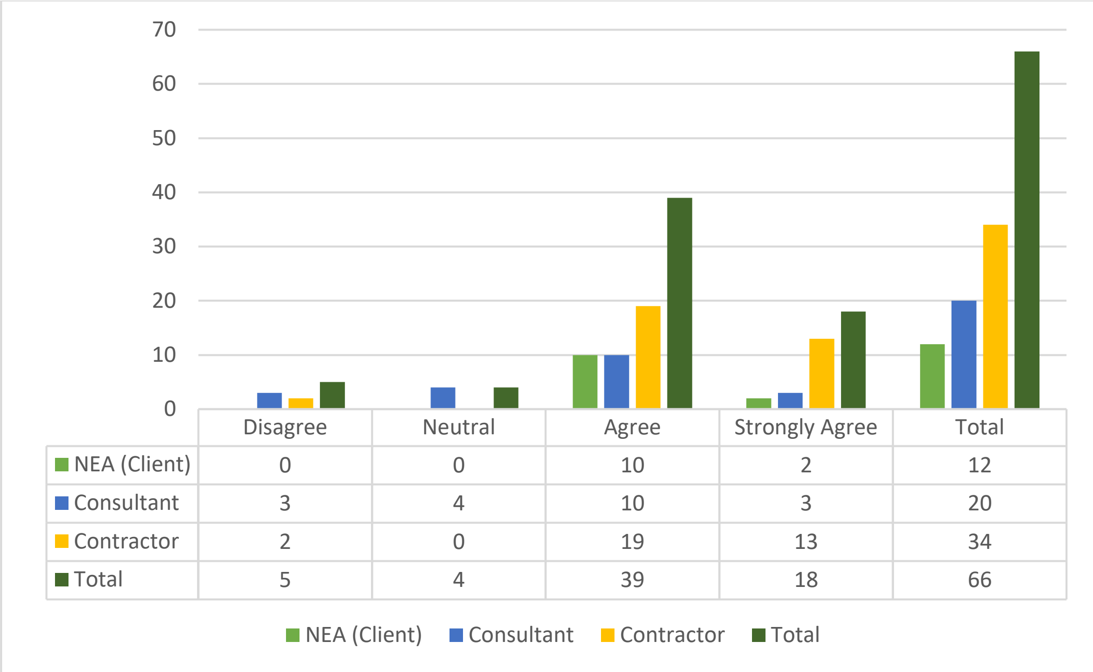

Figure 6: **Stakeholder Perception of Site Inspection Frequency**

The mean score for site inspection frequency is 4.06 (between Agree and Strongly Agree), with a standard deviation of 0.80. This indicates that stakeholders generally perceive site inspections as occurring regularly. However, the presence of some disagreement (8%) suggests that inspection frequency may vary by activity or site. This finding is consistent with the field observation results, where inspection-dependent activities (curing at 50%, earthwork testing at 63.3%) showed lower compliance, suggesting that while inspections occur, they may not be sufficiently frequent or thorough for all activities.

4.1.7 Perceived Documentation and Record Keeping

Table 16 presents stakeholder perceptions of documentation and record-keeping practices.

Table 15: Stakeholder Perception of Documentation and Record Keeping

Organization	Disagree	Neutral	Agree	Strongly Agree	Total
NEA (Client)	4	2	6	0	12
Consultant	4	4	8	4	20
Contractor	0	6	9	19	34
Total	**8**	**12**	**23**	**23**	**66**

Figure 7 illustrates the perceived documentation practices.

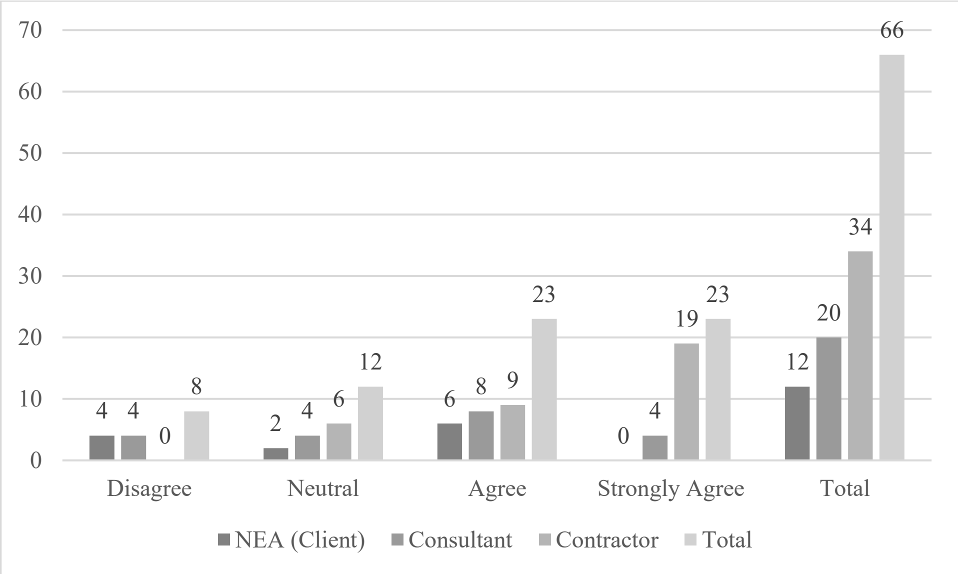

Figure 7: Stakeholder Perception of Documentation and Record Keeping

The mean score for documentation practices is 3.92 (approaching Agree), but the standard deviation of 1.01 is the highest among all QA/QC variables, indicating substantial variability in stakeholder perceptions. Notably, 12% of respondents disagreed and 18% were neutral, suggesting that documentation practices are not uniformly perceived as adequate. This finding aligns with field observations, where documentation and QA/QC practices showed only 63.3% compliance. The high variability suggests that while some projects maintain good records, others do not. This inconsistency was also identified by Shrestha et al. (2022) as a common challenge in Nepalese construction projects.

4.1.8 Perceived Compliance with ADB and NEA Standards

Table 17 presents stakeholder perceptions of compliance with ADB and NEA quality standards.

Table 16: Stakeholder Perception of Compliance with ADB/NEA Standards

Organization	Disagree	Neutral	Agree	Strongly Agree	Total
NEA (Client)	4	0	8	0	12
Consultant	2	2	11	5	20
Contractor	1	4	10	19	34
Total	**7**	**6**	**29**	**24**	**66**

Figure 8 illustrates the perceived compliance with standards.

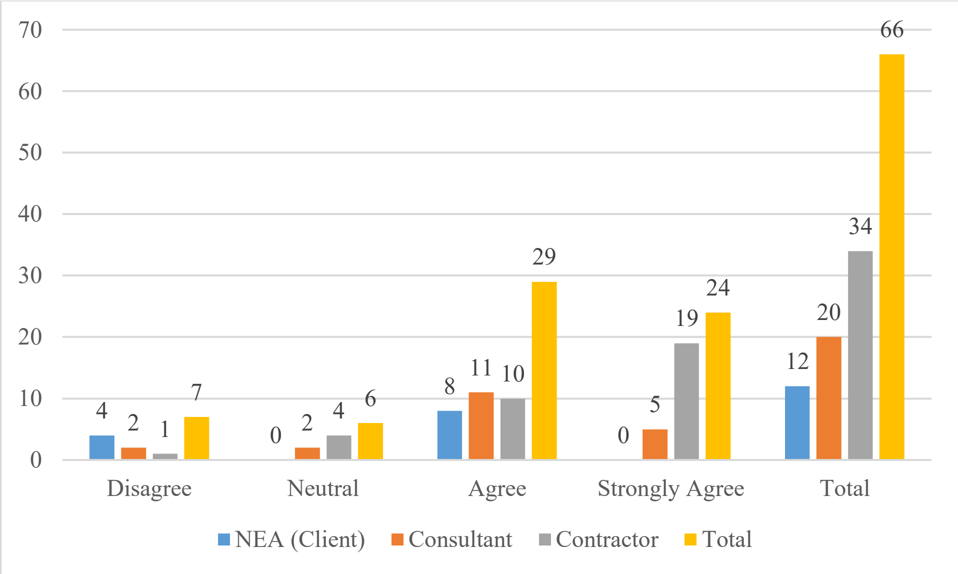

Figure 8: Stakeholder Perception of Compliance with ADB/NEA Standards

The mean score for compliance with ADB and NEA standards is 4.06, with a standard deviation of 0.94. While most stakeholders agree that projects comply with required standards, the presence of disagreement (11%) and neutral responses (9%) indicates that compliance is not perceived as uniform. Notably, 4 out of 12 NEA respondents (33%) disagreed that projects comply with standards, while only 1 contractor disagreed. This perception gap mirrors the ITP finding: client representatives perceive lower compliance than contractors.

4.1.9 Summary of Objective 1 Findings

Table 18 summarizes the descriptive statistics for all QA/QC variables.

Table 17: Summary of Stakeholder Perceptions of QA/QC Implementation

Variable	Mean	Std. Deviation	Perceived Level
FQP Implementation	4.15	0.36	Good
ITP Implementation	3.70	0.93	Moderate to Good
Material Testing	4.09	0.84	Good
Site Inspection	4.06	0.80	Good
Documentation	3.92	1.01	Moderate to Good
ADB/NEA Compliance	4.06	0.94	Good

Figure 9 presents the mean scores for all QA/QC variables.

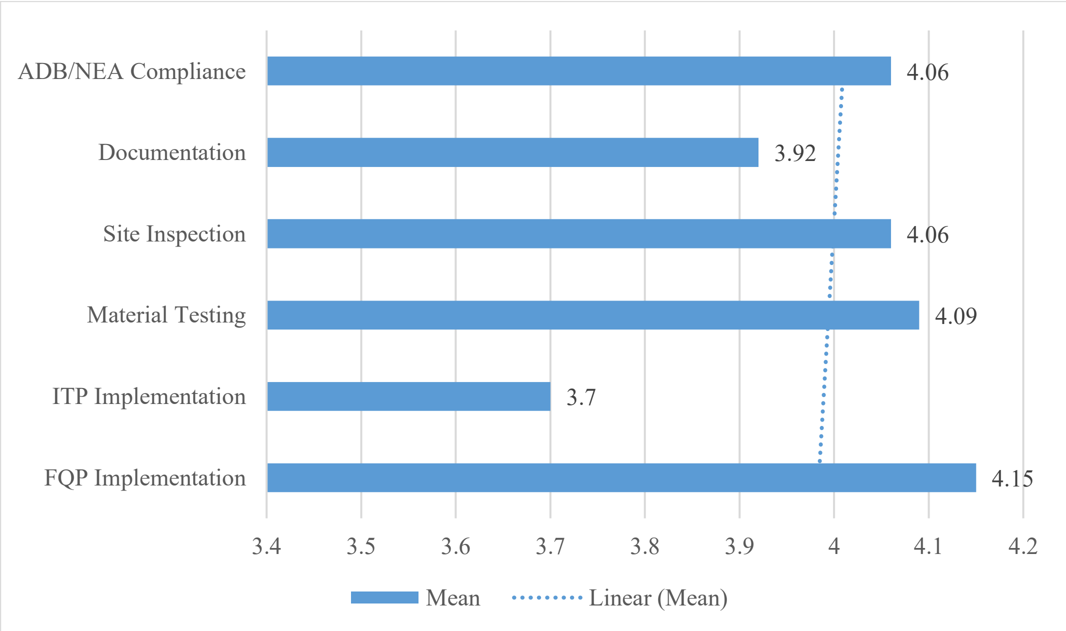

Figure 9: Mean Scores of Stakeholder-Perceived QA/QC Variables

From the stakeholder perspective, QA/QC implementation in ADB-funded GIS substations is generally perceived as moderate to good (mean scores ranging from 3.70 to 4.15). The highest perceived implementation is for FQP availability (4.15), confirming that the planning phase of QA/QC is well established. The lowest perceived implementation is for ITP implementation (3.70), with notable variation between client and contractor perceptions. Documentation shows the highest variability (SD = 1.01), indicating inconsistent practices across projects. The complementary field observation data (average compliance 67.7%) generally align with these perception findings, though perceptions tend to be slightly more positive than observed compliance levels.

4.2 Stakeholder-Identified Challenges in QA/QC Implementation

This section identifies and rank, from a stakeholder perspective, the major challenges affecting QA/QC implementation at the field level using RII where respondents were asked to rate six potential challenges on a five-point Likert scale. RII values were calculated and presented in table 19 below.

Table 18: RII Ranking of Stakeholder-Perceived Challenges

S.N.	Perceived Challenge	RII Value	Rank	Perceived Importance
1	Weak monitoring and supervision	0.82	1	Very High
2	Lack of skilled QA/QC personnel	0.79	2	High
3	Poor documentation practices	0.76	3	High
4	Coordination gaps among stakeholders	0.74	4	High
5	Delay in inspection and testing	0.71	5	High
6	Inadequate training on QA/QC procedures	0.69	6	Moderate to High
7	Limited use of digital monitoring tools	0.66	7	Moderate

4.2.2 Discussion of Each Perceived Challenge

Challenge 1: Weak Monitoring and Supervision (RII = 0.82, Rank 1)

Stakeholders identified weak monitoring and supervision as the most significant perceived barrier to effective QA/QC implementation. From the stakeholder perspective, increasing the frequency and effectiveness of site supervision would yield the highest immediate improvement in QA/QC implementation. This finding is consistent with

Abdul-Rahman et al. (2015), who found weak supervision as a primary cause of quality issues in Malaysian construction projects, and with Regmi et al. (2022), who identified inadequate supervision as a key risk in ADB-funded transmission projects in Nepal.

Challenge 2: Lack of Skilled QA/QC Personnel (RII = 0.79, Rank 2)

The second most significant perceived challenge is the shortage of qualified QA/QC personnel at site level. Key informant interviews revealed that while QA/QC engineers are sometimes assigned to projects, they often manage multiple sites simultaneously or lack specific training in GIS substation requirements. This perception aligns with Tam et al. (2018), who identified lack of contractor commitment and training as key barriers to quality plan implementation.

Challenge 3: Poor Documentation Practices (RII = 0.76, Rank 3)

Poor documentation practices ranked third, consistent with the high variability in documentation perceptions (SD = 1.01) reported in Section 4.1.6. Key informant interviews revealed that documentation is often treated as a compliance exercise for audits rather than a real-time management tool. Inspection reports may be completed after the fact, checklists may be signed without verification, and non-conformance reports may not be consistently tracked. This finding is consistent with Karki and Adhikari (2023), who identified poor documentation (RII = 0.78) as a top-ranked challenge in Nepalese infrastructure projects.

Challenge 4: Coordination Gaps Among Stakeholders (RII = 0.74, Rank 4)

Coordination gaps among client, consultant, and contractor ranked fourth. This perception gap was evident in the ITP implementation findings (Section 4.1.3), where 67% of NEA respondents disagreed that ITPs are followed, while all contractor respondents agreed. Key informant interviews revealed that coordination meetings occur but may not be sufficiently regular or may not result in actionable decisions. This finding aligns with Shrestha et al. (2022), who noted that poor coordination among project stakeholders is a recurrent issue in Nepalese construction projects.

Challenge 5: Delay in Inspection and Testing (RII = 0.71, Rank 5)

Delays in inspection and testing ranked fifth. Key informant interviews suggested that testing laboratories are sometimes located far from site locations, causing delays in material approval. Additionally, the need for third-party testing for certain GIS-specific components (e.g., SF_6 gas quality, partial discharge testing) may require specialized labs, leading to scheduling challenges. This finding is consistent with Zeng et al. (2019), who highlighted inspection delays as critical factors affecting construction quality.

Challenge 6: Inadequate Training on QA/QC Procedures (RII = 0.69, Rank 6)

Inadequate training ranked sixth. Key informant interviews revealed that while engineers receive general training on QA/QC principles, site-level workers and junior inspectors may not receive specific training on GIS substation requirements, international standards (IEC, IEEE), or documentation procedures. This finding aligns with the perceived lack of skilled personnel (Rank 2) and suggests that training programs targeted to GIS-specific QA/QC requirements could address multiple challenges simultaneously.

Challenge 7: Limited Use of Digital Monitoring Tools (RII = 0.66, Rank 7)

Limited use of digital monitoring tools ranked lowest, though still in the moderate importance range. Key informant interviews suggested that while digital tools are used for basic documentation (e.g., email, Word, Excel), integrated digital QA/QC systems (e.g., mobile inspection apps, cloud-based reporting, real-time dashboards) are not commonly used. Wang et al. (2020) noted that digital technologies in construction can enhance real-time tracking and reduce documentation delays.

4.2.3 Summary of Objective 2 Findings

Stakeholders perceive weak monitoring and supervision (RII = 0.82) as the most significant barrier to effective QA/QC implementation, followed by lack of skilled QA/QC personnel (RII = 0.79), poor documentation practices (RII = 0.76), and coordination gaps (RII = 0.74). These four challenges represent priority areas for intervention. The lower-ranked challenges inadequate training (0.69) and limited digital tools (0.66) are not unimportant, but stakeholders perceive them as less urgent. These findings provide a clear, stakeholder-informed prioritization for improving QA/QC practices in future GIS substation projects.

4.3 Stakeholder-Perceived Relationship Between QA/QC and Project Performance

For third objective of the study under which evaluation of stakeholder-perceived relationships between QA/QC implementation and project performance indicators: rework, construction progress, cost overrun, and project delay, Pearson’s correlation analysis was carried out to examine perceived relationships between overall QA/QC implementation scores (aggregated from Section 4.1 variables) and each performance indicator. Table 21 presents the correlation coefficients.

Table 19: Correlation Between Stakeholder-Perceived QA/QC and Project Performance

Variable Pair	Pearson Correlation (r)	p-value	Perceived Relationship Strength	Statistical Significance
QA/QC → Rework	-0.65	0.005	Strong (negative)	Significant ($p < 0.05$)
QA/QC → Construction Progress	0.58	0.089	Moderate (positive)	Not significant ($p > 0.05$)
QA/QC → Cost Overrun	-0.60	0.378	Moderate (negative)	Not significant ($p > 0.05$)
QA/QC → Project Delay	-0.55	0.068	Moderate (negative)	Not significant ($p > 0.05$)

Figure 10 illustrates the correlation coefficients.

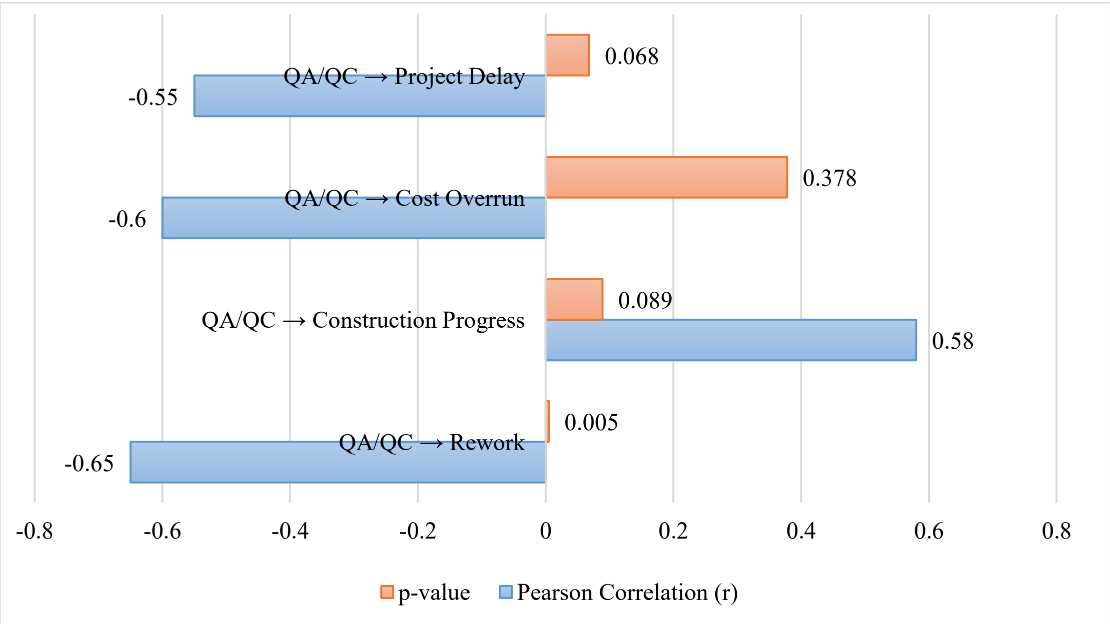

Figure 10: Correlation Between Perceived QA/QC and Project Performance

4.3.1 Discussion of Each Perceived Relationship

Perceived Relationship 1: QA/QC and Rework (r = -0.65, p = 0.005)

The strongest and most statistically significant perceived relationship is between QA/QC implementation and rework. The negative correlation (r = -0.65) indicates that stakeholders perceive stronger QA/QC practices as associated with less rework. The p-value of 0.005 (below 0.05) confirms statistical significance at the 95% confidence level.

This finding aligns with established construction management literature. Love et al. (2016) reported that rework costs typically range from 5–15% of project cost, and that effective QA/QC systems are the primary mechanism for rework prevention. From the stakeholder perspective, activities such as proper material testing (mean = 4.09) and regular site inspections (mean = 4.06) are seen as directly contributing to fewer defects and less corrective work.

Perceived Relationship 2: QA/QC and Construction Progress (r = 0.58, p = 0.089)

A moderate positive correlation (r = 0.58) suggests that stakeholders perceive better QA/QC as associated with **faster construction progress**. However, the p-value of 0.089 is above 0.05, indicating that this relationship is not statistically significant.

The lack of statistical significance is itself an interesting finding. It suggests that while stakeholders perceive a positive relationship between QA/QC and progress, this perception is not as strong or consistent as the rework relationship. There may be a common perception that QA/QC activities "slow down" construction. The positive (but non-significant) correlation suggests that some stakeholders recognize that preventing defects actually saves time in the long run, while others remain focused on short-term productivity. Hoonakker et al. (2017) found that projects with structured QA/QC systems showed 20–30% improvement in performance metrics, including schedule adherence.

Perceived Relationship 3: QA/QC and Cost Overrun (r = -0.60, p = 0.378)

A moderate negative correlation (r = -0.60) suggests that stakeholders perceive better QA/QC as associated with **lower cost overruns**. However, the p-value of 0.378 is well above 0.05, indicating that this relationship is not statistically significant.

The lack of statistical significance may reflect that cost overruns are influenced by many factors beyond QA/QC including material price fluctuations, currency exchange rates (for imported GIS components), labor availability, and unforeseen site conditions. Jetley

(2016) and Rajguru (2016) both noted that cost optimization in construction is closely linked with quality management, as poor quality leads to increased rework and lifecycle costs.

Perceived Relationship 4: QA/QC and Project Delay (r = -0.55, p = 0.068)

A moderate negative correlation (r = -0.55) suggests that stakeholders perceive better QA/QC as associated with **fewer project delays**. The p-value of 0.068 is close to but slightly above the 0.05 significance threshold. This is often described as "marginally non-significant" or trending toward significance.

The near-significant finding suggests that with a larger sample size, this relationship might achieve statistical significance. Key informant interviews revealed that delays in inspection and testing (RII = 0.71) were perceived as a challenge, suggesting that when QA/QC processes themselves cause delays, stakeholders may not see QA/QC as schedule-enhancing. However, when QA/QC prevents rework, it prevents the larger delays that would otherwise occur.

4.3.3 Summary of Objective 3 Findings

Stakeholders perceive the strongest and most statistically significant relationship between QA/QC implementation and rework reduction (r = -0.65, p = 0.005). This finding is robust and aligns with established literature. Stakeholders also perceive moderate relationships between QA/QC and progress (r = 0.58), cost overrun (r = -0.60), and delay (r = -0.55), though these relationships did not achieve statistical significance at the 95% confidence level. Importantly, the direction of all relationships is consistent: better QA/QC is perceived as associated with better project performance across all four indicators.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusions

This study evaluated stakeholder perceptions of Quality Assurance and Quality Control (QA/QC) implementation in ADB-funded Gas Insulated Substation (GIS) projects within Kathmandu Valley. Based on survey responses from 66 stakeholders including clients (NEA), consultants, and contractors the following overall conclusions are drawn:

- From the stakeholder perspective, the planning phase of QA/QC—particularly Field Quality Plans (FQP)—is well established and consistently perceived as present across all projects. However, the translation of these plans into consistent field-level implementation shows variability, particularly in ITP adherence and documentation practices.
- A notable finding is the systematic perception gap between NEA (client) representatives and contractors. NEA respondents consistently perceived lower levels of ITP implementation and compliance with ADB/NEA standards compared to contractors. This gap itself is a finding: it suggests misalignment in expectations, communication, or standards of compliance.
- Stakeholders identified weak monitoring and supervision (RII = 0.82) and lack of skilled QA/QC personnel (RII = 0.79) as the top two barriers to effective QA/QC implementation. These human resource and supervisory factors are perceived as more critical than documentation systems or digital tools.
- Stakeholders perceive the strongest and most statistically significant relationship between QA/QC implementation and rework reduction ($r = -0.65$, $p = 0.005$). While QA/QC is also perceived as positively associated with progress, cost control, and schedule adherence, these relationships are perceived less consistently.
- The RII rankings provide a clear, stakeholder-informed prioritization for intervention: (1) strengthen monitoring and supervision, (2) deploy skilled QA/QC personnel, (3) improve documentation practices, and (4) enhance coordination among stakeholders.

5.4 Recommendations from the Study

Based on the stakeholder-perceived priorities identified through RII analysis and the key findings from all three objectives, the following five major recommendations are proposed to strengthen QA/QC implementation in future ADB-funded GIS substation projects in Nepal.

- Strengthen Monitoring and Supervision
    - Weak monitoring and supervision were the most critical barrier (RII = 0.82). Project agencies should increase supervision frequency, particularly for less visible activities such as curing and earthwork testing. Dedicated supervisors should be assigned for GIS-specific installation work, including SF_6 gas handling and equipment alignment.
- Deploy Skilled QA/QC Personnel with GIS Training
    - Lack of skilled personnel ranked second (RII = 0.79). Contractors should deploy dedicated, certified QA/QC engineers who are not assigned to multiple sites. These personnel must receive specialized training on IEC and IEEE standards, GIS erection procedures, and documentation protocols.
- Standardize Documentation and Close Perception Gaps
    - Poor documentation ranked third (RII = 0.76), and notable perception gaps existed between client and contractor. Standardized QA/QC checklists and report templates should be implemented. Regular joint audits involving all stakeholders should be conducted at project milestones to align expectations.
- Establish Mandatory Coordination Mechanisms
    - Coordination gaps ranked fourth (RII = 0.74). Weekly QA/QC coordination meetings among NEA, consultant, and contractor should be mandated with documented action items and tracking of resolutions.
- Integrate QA/QC into Scheduling and Use Digital Tools
    - Inspection delays (RII = 0.71) and limited digital tools (RII = 0.66) remain relevant concerns. Contractors should integrate QA/QC hold points into project schedules. ADB and NEA should pilot digital QA/QC systems, such as mobile inspection apps or cloud-based documentation platforms, in future projects.

5.6 Recommendations for Future Research

- Future research should compare stakeholder perceptions with objective quality metrics through independent compliance audits.
- Comparative studies between ADB-funded and non-ADB funded GIS substations would determine whether funding sources influence QA/QC implementation.
- Longitudinal research tracking perceptions across project phases would reveal how views evolve over time.
- Cost-benefit analysis of specific QA/QC interventions would quantify financial returns on quality investments.
- Finally, pilot studies of digital QA/QC monitoring tools in actual GIS substation projects would provide empirical evidence on their effectiveness.

REFERENCES

Asian Development Bank. (2017). *ADB procurement policy: Goods, works, nonconsulting and consulting services*. https://www.adb.org/documents/adb-procurement-policy

Carvalho, M. M., & Rabechini, R. (2017). Can project sustainability management impact project success? An empirical study applying a contingent approach. *International Journal of Project Management, 35*(6), 1120–1133. https://doi.org/10.1016/j.ijproman.2017.02.012

Chang, Y., et al. (2018). Effects of green construction site practices on the economic performance of construction projects. *Journal of Facilities Management, 16*(3), 331–349. https://doi.org/10.1108/JFM-03-2018-0020

European Commission. (2015). *Closing the loop – An EU action plan for the circular economy*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614

Geng, Y., & Doberstein, B. (2008). Developing the circular economy in China: Challenges and opportunities for achieving 'leapfrog' development. *International Journal of Sustainable Development & World Ecology, 15*(3), 231–239. https://doi.org/10.3843/SusDev.15.3:6

Gulghane, A. A., & Khandve, P. V. (2015). Management for construction materials and control of construction waste in construction industry: A review. *International Journal of Engineering Research & Technology, 4*(3), 1005–1010.

Institute of Electrical and Electronics Engineers. (2021). *IEEE standard for high-voltage gas-insulated substations rated above 52 kV* (IEEE Std C37.122-2021). https://doi.org/10.1109/IEEESTD.2021.9525322

International Electrotechnical Commission. (2022). *High-voltage switchgear and controlgear – Part 203: Gas-insulated metal-enclosed switchgear for rated voltages above 52 kV* (IEC 62271-203:2022).

Jetley, A. (2016). Cost optimization in construction projects: Concepts and techniques. *International Journal of Construction Management, 16*(4), 289–301.

Liu, H., Xiao, Y., Qiu, S., Zhao, X., Chen, X., Liu, Z., & Sun, J. (2022). Analysis and detection of fault for substation GIS insulating part based on integrated automation system data. *Journal of Physics: Conference Series, 2276*(1), Article 012020. https://doi.org/10.1088/1742-6596/2276/1/012020

Nepal Electricity Authority. (2019). *Bidding document for procurement of plant: Design, supply, installation and commissioning of 400 kV gas insulated substations at New Khimti, Barhabise and Lapsiphedi* (Vols. I & II). https://www.nea.org.np

Quacci, F. (2017). *Quality control activities and lifecycles cost management over smart grid components* [Master's thesis, Politecnico di Milano].

Rajguru, A. (2016). Effective techniques in cost optimization of construction project: A review. *International Journal of Engineering Research & Technology, 5*(3), 456–462.

Regmi, S., Kandel, A., Shiwakoti, S., & Dhital, M. R. (2022). Risk management of high voltage transmission line project: A case study of ADB funded projects in Nepal. *International Journal of Engineering Applied Sciences and Technology, 6*(10), 94–105.

Solar Radiation Theory. (2019). Seasonal solar variations and their impact on solar energy availability. In *Solar energy fundamentals* (pp. 45–68). Academic Press.

Zhang, P., & Peng, B. (2017). Energy management practices on construction sites: A review of current approaches and future directions. *Journal of Cleaner Production, 152*, 456–468. https://doi.org/10.1016/j.jclepro.2017.03.145

APPENDIX A: Questionnaire

Questionnaire for "Analysing Implementation of Quality Assurance and Quality Control Measures in an ADB-Funded GIS Substation within Kathmandu valley: A Case Study of Lapshiphedi Substation"

Background Information

The construction industry plays a vital role in the economic development of Nepal, particularly in the expansion of critical infrastructure such as power transmission and distribution systems. In recent years, significant investments have been made in substation projects, especially Gas Insulated Substations (GIS), under the support of organizations like the Asian Development Bank. These projects demand strict adherence to Quality Assurance and Quality Control (QA/QC) practices to ensure safety, reliability, and long-term performance.

However, the effective implementation of QA/QC measures in construction projects in Nepal remains a challenge. Issues such as inadequate supervision, lack of skilled manpower, poor documentation practices, weak compliance with standards, and limited coordination among stakeholders often hinder the quality performance of projects. In the context of GIS substations, which involve complex electrical and civil works, these challenges become even more critical.

This study aims to assess the current status of QA/QC implementation in ADB-funded 132 kV GIS substation projects within Kathmandu Valley. It also seeks to identify key factors affecting quality management practices and evaluate their impact on project outcomes such as rework, cost overrun, construction progress, and project delays.

The purpose of this questionnaire survey is to collect insights from professionals including clients, consultants, contractors, and site engineers who are directly involved in such projects. The findings will contribute to recommending practical measures for improving QA/QC practices in future infrastructure development.

This survey is conducted as a partial fulfillment of the requirements for the Degree of Master of Science in Construction Management at the Institute of Engineering, Tribhuvan University. The questionnaire will take approximately 5–10 minutes to complete. All responses will be used solely for academic research purposes and will be kept strictly confidential.

Section A: General Information

1. **Your organization:**

   ☐ NEA ☐ Consultant ☐ Contractor

2. **Current designation:**

   ☐ Engineer ☐ Site Engineer ☐ QA/QC Engineer ☐ Project Manager ☐ Other: ________

3. **Primary role in the Lapshiphedi GIS Substation Project:**

   ☐ Design & Review

   ☐ Construction Execution

   ☐ Quality Control / Inspection

   ☐ Supervision & Monitoring

   ☐ Contract Administration

4. **Years of professional experience in construction projects:**

   ☐ Less than 5 years

   ☐ 5–10 years

   ☐ More than 10 years

5. **Experience in GIS Substation / Power Sector Projects:**

   ☐ Yes ☐ No

6. **Experience in ADB or other donor-funded projects:**

   ☐ Yes ☐ No

7. **Level of involvement in QA/QC activities on this project:**

   ☐ High ☐ Moderate ☐ Low

Section B: QA/QC & FQP Implementation

4. An approved QA/QC Plan and Field Quality Plan (FQP) is available at the Lapshiphedi GIS Substation site.

5. Inspection and Test Plans (ITPs) are clearly defined and followed during construction activities.
6. Material inspection and testing are conducted as per approved specifications.
7. Site inspections are carried out regularly by responsible authorities.
8. QA/QC documentation and records are properly maintained at site.
9. Construction activities comply with ADB and NEA quality standards.

Section C: Challenges and Gaps in QA/QC Implementation

10. Lack of skilled QA/QC manpower affects effective quality control at site.
11. Insufficient training and awareness on QA/QC procedures is a major issue.
12. Time pressure due to tight schedules compromises QA/QC practices.
13. Limited resources and testing facilities hinder QA/QC implementation.
14. Poor coordination among client, consultant, and contractor affects quality management.
15. Monitoring and supervision of QA/QC activities are inadequate.

Section D: Impact of QA/QC on Project Performance

16. Poor QA/QC implementation has led to rework in the project.
17. Non-conformance reports (NCRs) have affected construction progress.
18. QA/QC issues have contributed to cost overruns in the project.
19. Weak QA/QC practices have caused delays in project completion.
20. Effective QA/QC implementation improves overall project quality.
21. Strong QA/QC practices help control project cost and schedule.

Section E: Improvement Measures

22. Regular QA/QC training programs should be provided to site staff.
23. Digital QA/QC documentation systems should be adopted.
24. Clear responsibility allocation improves QA/QC effectiveness.
25. Stronger enforcement of QA/QC provisions in contracts is required.

APPENDIX B: Field Quality Plan Sample

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Page1 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting Authority in Consultant/ NEA
					Agency	Extent		
1.	Earth Work (site leveling)							
		Mandatory testing for filling						
			1. Proctor compaction test for maximum dry density	IS:2720(part-7) & As per TS	Contractor/ from Consultant/NEA approved Lab	One sample per 25,000 Cu. m. for each type & source of filling material.	100% review of lab test results	Site In charge
			2. Optimum Moisture Content	Do	Contractor/ From Consultant/NEA approved Lab.	Do	Do	Do
		Field Compaction Test	1. Field dry density & Moisture content test for each layer of compaction.	IS:2720 (part-29) & As per TS	Contractor Field lab./ Consultant /NEA approved Lab.	One sample for every 2500 sq. or part there of for compacted soil for each compacted layer.	Do	Do
2.	Civil works							
	A. Materials	1. Cement	1. Brand approval	Cement of Approved Brands according to the Consultant/NEA	Contractor	As proposed by Contractor	Any new brand cement proposed by Contractor shall be approved by Consultant/NEA.	Site In charge
			2. Physical tests	As per document at Annexure-I of this FQP	Contractor Samples to be taken jointly with Consultant/NEA and tested at Consultant/NEA accepted lab.	-Review of 100% MTC's One sample of each brand from one manufacturing unit for each contract. (Further refer note-17 at page 24). (If cement is stored for more than 3 months, testing is to be done before its use)	100% review of lab test results Test results shall be sent by the Lab, by e mail directly to Consultant. Further, hard Copy of Test Certificate shall also be sent by the Lab directly to Consultant on Postal Address.	Site In charge

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Page2 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
2	Material	1. Cement	3. Chemical Tests. Chemical composition of Cement	-Do-	Contractor to submit MTC	Review of all MTC	100% review of MTC results	Site In charge
		2.a) Reinforcement Steel	1. Source approval	- May be procured from producers directly or through authorized dealers who can produce MTC from main producers with traceability.	Contractor	As proposed by contractor	Material shall be supplied from producers/authorized dealers.	Site In charge.
			2. Physical and Chemical analysis test	As per Annexure-2 of this FQP	Contractor to submit MTC.	Review of 100% MTC One sample* / 300 MT / Manufacturer shall be jointly sealed by Consultant and tested at Consultant approved Lab. *Note: All sizes of 10mm and above shall be taken for testing in every 300MT Lab.	-100% review of MTC. 1. Review of lab test results. Test results shall be sent by the Lab, by E mail directly to Consultant; further, hard Copy of Test Certificate shall also be sent by the Lab directly to Consultant/NEA on Postal Address. 2. Unit weight of these samples to be witnessed.	Site In charge Site Engineer Site Engineer

* The samples of each size reinforcement steel (all size 10mm & above) out of 100MT steel lot had to be physically weighed at site in presence of NEA/Consultant to ascertain their acceptance as per technical specification. The weighed samples at site may be kept under custody for 3 months for further examination of any auditing agency (if required)

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Page3 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
2	Material	2. b) Structural steel. For roof truss, door & window frames, boundary wall, gates, grills, railings gratings & rolling shutter etc.	Source to be proposed by contractor.	As per TS	Contractor	As proposed by contractor	To verify documents.	Site In charge
			1. Visual & Dimensional check for damages, rusting & pitting, welding, primer coating, painting/ galvanizing as applicable.	As per TS & Approved Drawings	Contractor	100%	Random	Site Engineer
			2. Physical properties a) Structural steel (except tubular pipes)	As per TS & approved drawing	Contractor	1 sample per 20 MT or part thereof for tensile and bend test of each size. Samples to be tested in Consultant accepted lab.	Review of lab. Tests results by Consultant.	Site Engineer
			b) Steel Tubular pipes	Do	Contractor	1 sample per 8 MT or part thereof for tensile and bend test of each size. Samples to be tested in Consultant accepted lab	Review of lab. Tests results by Consultant.	Site Engineer

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCER/FQP/02
REV.	R02

Page4 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
2	Material	3. Course Aggregates	1. Source approval	Source meeting As per TS	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in Consultant accepted lab.	To review the proposal based on the documents	Site In charge. Once approved, the particular quarry shall be used for all the running contracts under various Packages.
			2. Physical tests	As per document at Annexure-3 of this FQP	Samples to be taken jointly and tested in Consultant/NEA accepted lab	One sample per 500 cum or part thereof for each source and size samples to be tested by contractor in Consultant accepted lab.	100% review of test results. Out of these 100% samples, Consultant shall witness at TPL, 5 samples selected at random, spread during the overall execution period of contract.	Site In charge
		4. Fine aggregate	1. Source approval	Source meeting As per TS	Contractor	Proposed by Contractor, indicating the location of the quarry and based on the results of Joint samples tested in Consultant accepted lab.	To review the proposal based on the documents.	Site In charge Once approved, the particular source shall be used for all the running contracts under various Packages.
			2. Physical test	As per Annexure-4 of this FQP	Samples to be taken jointly and tested in Consultant/NEA accepted lab.	One sample per 500 cum or part thereof for each source. Samples to be tested by contractor in Consultant accepted lab.	100% review of test results Out of these 100% samples, Consultant shall witness at TPL, 5 samples selected at random, spread during the overall execution period of contract.	Site In charge

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
2	Material	5. Water	1. Cleanliness	As per TS (Water shall be fresh and clean)	Contractor	100% visual check at Field	Verification at random	Site Engineer
			2. PH Value	- Do -	Contractor	One sample per source	100% review of the test results Ph value not less than 6	Site Engineer
		6. Finishing materials of Building	Physical verification of Different items per TS.	As per TS.	Contractor	100%	MTC/Manufacturer catalogue to be reviewed by Consultant.	Site In charge
3	Concrete Works							
	a) Before Concreting	1. Dimension of excavation.	Dimension & Depth of Foundation	Approved Drawings	Contractor	100% at Field.	100% check by Consultant.	Site Engineer.
		2. Stub setting/Setting of Foundation Bolts, Embedment's, etc.	1) Center Line	-Do-	-Do-	-Do-	-Do-	-Do-
			2) Diagonals	-Do-	-Do-	-Do-	-Do-	-Do-
			3) Level of stubs/ Foundation Bolts	-Do-	-Do-	-Do-	-Do-	-Do-
		3) Reinforcement Steel	Placement	Bar bending schedule	-Do-	-Do-	-Do-	At least 5% location shall be cross verified by Site In charge at random with respect to stub setting & steel reinforcement placement.

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
3.	a) Before Concreting	4) Concrete Mix. Portion (Applicable for Design mix.)	Ratio of mix. portion	Approval of Design mix. Submitted by contractor based on inputs furnished by Consultant as per Annexure-9 of this FQP	-Do-	-Do-	-Do-	Site In charge
	b) During Concreting	1.Workability (For concreting not less than 1:3 : 6)	Slump test	Range 25 mm to 75 mm. As per refer document at Annex -5 of this FQP.	Contractor	Minimum 01 sample per day / conc. mixer	20% check at random	Site Engineer
		2.Concrete Strength (For R.C.C.)	Cubes Compressive Strength	As per TS & Annexure-5 of this FQP.	Contractor Casting of cubes at site. Cubes to be tested for 28 days' strength at Consultant/NEA approved. Lab / Consultant Lab/At site- (if testing machine installed by contractor, is duly calibrated by Govt. Lab) Cubes at 100% location are to be taken in presence of Consultant officials	One sample of 3 cubes for every 20 Cum or part thereof. (Mini. Qty. required for testing is 5 cu. m. for each day of concrete)	100% review of lab test results. Cubes at 100% location are to be taken in presence of Consultant officials. Normally testing shall be carried out at the Cube Testing Facility installed by contractor at site premises, in the witness of Consultant. Alternatively, samples shall be tested at Consultant approved Labs. In this case, test results shall be sent by the Lab, by e mail directly to Consultant; Further, hard Copy of Test Certificate shall also be sent by the Lab directly to Consultant on Postal Address. Further, Consultant to witness testing on 20% samples and also to review 100% test results.	Site Engineer Out of testing on 10% samples to be witnessed at TPL by Consultant Site Engineer. At least 5% sample at random shall be witnessed by Site In charge.

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Page7 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
3.	c) After Concreting Back Filling	Watering & Ramming for compaction.	a) Watering ramming for compaction.	As per TS	Contractor	100%	Random	Site Engineer
			b) Compaction Test	As per TS	Contractor/ Consultant /NEA approved. Lab ,	1. One sample of three specimens for 50% of Tower location. 2. One sample of three specimens for 20% of equipment foundation location. 3. Three samples for every Building (The depth of sampling and the locations shall be decided by Site Engineer)	100% review of Test Results.	Site In charge
		C) NDT or Core Tests	d) UPV and Rebound Hammer Test	Refer Standard Procedure for Testing	Assessment of compression strength of casted concrete. This may be used in case of cubes are failing.			Site In charge

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Page8 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
4.	Brick Masonry							
		a) Bricks	1.Dimensional tolerance	As per TS/Enclosed Annexure 6	Contractor (samples to be taken jointly and tested in Consultant/NEA accepted lab)	Enclosed Annexure -6	Review 100% of test results	Site Engineer
			2.Compressive strength	As per TS/Enclosed Annexure 6	-Do-	-Do-	-do-	Site Engineer
			3.Water Absorption	As per TS/Enclosed Annexure 6	-Do-	-Do-	-do-	Site Engineer
			4.Efflorescence	As per TS/Enclosed Annexure 6	-Do-	-Do-	-do-	Site Engineer
		b) Mortar Mix.	Cement sand Proportion	As per TS	Contractor	100%	Random	Site Engineer
5.	Stone Masonry							
		Stone	1.Compressive Strength	As per IS 1121(Part-) Stone with round surface shall not be used	Contractor (samples to be taken jointly and tested in Consultant/NEA accepted lab)	One sample per source	random	Site In charge
			2. Water Absorption	As per IS1124-1974. Stone with round surface shall not be used	Contractor (samples to be taken jointly and tested in Consultant/NEA accepted lab)	One sample per source	random	Site In charge

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Page9 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
6.	P.C.C.							
		Grade, Thickness, Plan, Dimension	Completeness	IS456:2000 & As per TS & Approved foundation dwgs.	Joint inspection by Consultant/NEA & Contractor	For all locations	Joint inspection by Consultant & Contractor	Site Engineer
7.	Plastering							
		1.Plastering	Thickness and evenness	As per TS	Contractor	100%	Random	Site Engineer
		2.Ingredients	Mortar/Mix. Proportion	As per TS	Contractor	100%	Random	Site Engineer
8.	Tiles for Flooring & Walls							
		1.Terrazo Tile	1.Wet Transverse Strength 2. Water Absorption 3. Abrasion Test	As per IS 1237 &, TS/ enclosed Annexure-7	Samples to be taken jointly and tested in Consultant/NEA accepted lab	One sample for every 10000 tiles or part thereof /enclosed Annexure-7	100% review of the test results.	Site In charge.
		2.Glazed tiles 3.Vitrified Tiles	1.Water Absorption 2.Crazing Test 3.Impact Test Strength	As per IS 15622 & TS	Samples to be taken jointly and tested in Consultant/NEA accepted lab.	One sample for every 3000 tiles or part thereof. (Minimum quantity of material for carrying out test is 3000 nos.)	100% review of the test results.	Site In charge.
9.	Finishing materials of building	Type / quality /class of finishing building material	Physical verification of Different items as per specification	As per TS	Contractor	100%	MTC/Manufacturer catalogue To be reviewed.	Site In charge.

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Page10 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
10.	Timber	1.Timber for Door & Window Frame	1. Moisture content	As per IS 287	Samples to be taken jointly and tested	One sample per cu. m or part thereof (No testing required below 1 cu.m.)	100% review of the test results.	Site In charge.
		2. Flush Door shutters (factory made)	1.End Immersion Test 2. Knife Test 3.Glue Adhesion Test	As per TS	Samples to be taken jointly and tested in Consultant/NEA accepted lab.	One sample for every 50 shutters or part thereof. (Mini. qty. of shutters for carrying out the test shall be 26 nos.).	100% review of the test results.	Site In charge.
11.	Aluminum Door& window sections	1. Anodic coating	Coating	As per IS 5523, As per TS & approved drawings.	Contractor	One sample for every 200 Kgs or part thereof. (Mini. Qty. required for testing is 100 kgs.	100% review of the test results	Site Engineer
12.	G.S. Barbed Wire	G.S. Barbed Wire	1. Visual Check 2. Dimensions, Weight & Size.	As per IS 278 & TS Refer Annexure-7 of this FQP.	Contractor Contractor	100% As per sampling plan at Annexure-7	Random Random	Site Engineer Site Engineer
			3. Tensile test, zinc coating test and ductility test	As per IS 278 & TS. (Refer Annexure-7 of this FQP)	Manufacturer's MTC / Third Party lab	As per sampling plan at Annex-7	Review of manufacturer's/TPL test certificates	Site Engineer

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Page11 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
13.	Switchyard Earthing							
		1.Check for dimension of earth mat	Physical Check	As per TS & Approved Dwgs.	Contractor	100%	Random	Site Engineer
		2.Depth of excavation	Physical Check	As per TS & Approved Dwgs.	Contractor	100%	Random	Site Engineer
		3.Check for weld joint and anticorrosion treatment	Physical Check	As per TS & Approved Dwgs.	Contractor	100%	Random	Site Engineer
14.	Site Surfacing							
		1.Levelling: Level, height & evenness	Physical Check	As per TS & Approved Dwgs.	Contractor	100%	Random	Site Engineer
		2.Soil sterilization: Spraying of chemicals	Physical Check	As per TS & Manufacturer recommendations	Contractor	100%	Random	Site Engineer
		3.P.C.C.(Grade, thickness & size)						
		a)P.C.C.1:5:10(1 Cement, 5 coarse fine sand,10 burnt brick aggregates)	Completeness	As per TS	Joint inspection by consultant/NEA and contractor.	100%	Random	Site Engineer
		b) Burnt brick aggregates of nominal size 40 mm	Grading	As per Annex. 8	Samples to be taken jointly and tested in Consult./NEA accepted lab	1 Sample per 500 cu.m.	100% review of lab test result	Site Engineer
		4.20/40 mm stone aggregates	Grading	IS 383:2016 & As per TS	Contractor & Consultant /NEA accepted lab.	1 Sample per lot for 500 cu.m. or part thereof from each source of each size	100% review of lab test report	Site Engineer

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Page12 of 27

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing		Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
					Agency	Extent		
14.		5.Resistivity of 20/40 mm stone aggregates	Electrical Check	As per TS	Contractor	1 Sample of stone from each source(In case stone are supplied from more than one source)	100% review of lab test report	Site Engineer
		6.Compacted thickness of 20/40 mm stone layers as applicable	Physical	As per TS & Approved Dwgs.	Contractor	100%	Random	Site Engineer
15.	Road (WBM layers)							
	Material	A. Coarse Aggregates	1.Source approval	Source with materials meeting TS	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in OWNER accepted lab.	To review the proposal based on the documents	Site In charge
			2.Physical tests	As per document at Annexure-8 of this FQP	Samples to be taken jointly and tested in Consultant/NEA approved lab.	One sample per 200 cum or part thereof per source. (Mini. Qty. required for testing is 100 cu. m.)	100% review of lab test results	Site In charge
		B. Stone Screening						
			1.Source approval	Source with materials meeting TS	Contractor	Proposed by the Contractor, indicating the location of the quarry and based on the test results of Joint samples tested in Consultant accepted lab.	To review the proposal based on the documents	Site In charge

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

S. N.	Description of Activity	Items to be Checked	Tests/Checks to be done	Ref. documents	Check/Testing: Agency	Check/Testing: Extent	Counter Check/Test by Consultant/NEA	Accepting authority in Consultant/NEA
15.	Material		2. Gradation	As per document at Annexure-8 of this FQP	Samples to be taken jointly and tested in Consultant/NEA accepted lab.	One sample per 200 cum or part thereof. (Mini. Qty. required for testing is 50 cu. m.)	100% review of lab test results	Site In charge
		C. Binding Material	Plasticity index	As per document at Annexure-8 of this FQP	Contractor	One sample per lot of 25 cu.m. or part thereof. (Mini. Qty. required for testing is 25 cu. m.)	100% review of lab test results	Site In charge
		D. Laying of sub base Course	Physical check	As per TS	Contractor	100%	Random	Site Engineer
		E. Laying of base Course	Physical check	As per TS	Contractor	100%	Random	Site Engineer
16.	Drain							
		Alignment and invert level	Physical check	As per TS & Approved Dwgs.	Contractor	100%	Random	Site Engineer

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Annex-I
(Sheet 01 of 03)

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR CEMENT

ORDINARY PORTLAND CEMENT

S. N.	Name of the Test	Ordinary Portland Cement 33 grade as per IS 269	Ordinary Portland Cement 43 grade as per IS 269	Ordinary Portland Cement 53 grade as per IS 269	Remarks
a)	Physical tests				To be conducted in Approved. Lab
(i)	Fineness	Specific surface area shall not be less than 225 sq.m. per Kg. or 2250 Cm2/gm. OR The retained weight shall not exceed 10% of Total weight.	Specific surface area shall not be less than 225 sq.m. per Kg or 2250 Cm2/gm. OR The retained weight shall not exceed 10% of Total weight.	Specific surface area shall not be less than 225 sq.m. per Kg or 2250 Cm2/gm. OR The retained weight shall not exceed 10% of Total weight.	Blaine's air permeability method as per IS Standard
(ii)	Compressive strength	72 ± 1 hour : Not less than 16 Mpa (16 N/mm2) 168 ± 2 hour : Not less than 22 Mpa (22 N/mm2) 672 ± 4 hour : Not less than 33 Mpa (33 N/mm2)	72 ± 1 hour : Not less than 23 Mpa (23 N/mm²) 168 ± 2 hour : Not less than 33Mpa (33 N/mm²) 672 ± 4 hour : Not less than 43 Mpa (43 N/mm²)	72 ± 1 hour : Not less than 27Mpa (27 N/mm²) 168 ± 1 hour : Not less than 37Mpa (37 N/mm²) 672 ± 1 hour : Not less than 53 Mpa (53 N/mm²)	As per IS Standard
(iii)	Initial & Final setting time	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	Initial setting time : Not less than 30 minutes Final setting time : Not more than 600 minutes	As per IS Standard -do-
(iv)	Soundness	Unaerated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test.	Unaerated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test	Unaerated cement shall not have an expansion of more than 10mm when tested by Le Chatlier and 0.8% by Autoclave test.	Le Chatlier and Autoclave test as per IS Standard

Annex-I
(Sheet 02 of 03)

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

S. N.	Name of the Test	Ordinary Portland Cement 33 grade as per IS 269	Ordinary Portland Cement 43 grade as per IS 269	Ordinary Portland Cement 53 grade as per IS 269	Remarks
b)	Chemical composition tests				
					Review of MTC only
		a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02	a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.66 to 1.02	a) Ratio of percentage of lime to percentage of silica, alumina & iron oxide 0.80 to 1.02%	
		b) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	a) Ratio of percentage of alumina to that of iron oxide Minimum 0.66	a) Ratio of percentage of alumina to that of iron oxide Minimum 0.66%	
		c) Insoluble residue, percentage by mass Max. 4.00%	c) Insoluble residue, percentage by mass Max. 2.00%	c) Insoluble residue, percentage by mass Max. 2.00%	
		d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	d) Magnesia percentage by mass Max. 6%	
		e) Total sulphur content calculated as sulphuric anhydride (SO_3), percentage by mass not more than 2.5 and 3.0 when tri-calcium aluminate percent by mass is 5 or less and greater than 5 respectively.	e) Total sulphur content calculated as sulphuric anhydride (SO_3), percentage by mass not more than 2.5 and 3.0 when tri-calcium aluminate percent by mass is 5 or less and greater than 5 respectively.	e) Total sulphur content calculated as sulphuric anhydride (SO_3), percentage by mass not more than 2.5 and 3.0 when tri-calcium aluminate percent by mass is 5 or less and greater than 5 respectively.	
		f) Total loss on ignition shall not be more than 5 percent	f) Total loss on ignition shall not be more than 5 percent	f) Total loss on ignition shall not be more than 5 percent	

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Annex-1 (Sheet 03 of 03)

S. N.	Name of the test			Remarks
2.	POZZOLANA PORTLAND CEMENT AS PER IS 1489			
a)	Physical Tests	i) Fineness	Specific surface area shall not be less than 300 sq.m. per Kg. or 3000 Cm^2/gm	
		ii) Compressive strength	a) 72 ± 1 hour: Not less than 16 Mpa (16 N/mm^2) b) 168 ± 2 hour: Not less than 22 Mpa (22 N/mm^2) c) 672 ± 4 hour : Not less than 33 Mpa (33 N/mm^2)	
		iii) Initial & Final setting time	Initial setting time: Not less than 30 minutes Final setting time : Not more than 600 minutes	
		iv) Soundness	Unaerated cement shall not have an expansion of more than 10mm Le Chatlier test and 0.8% by Autoclave test as per IS 4031 (Part-3)	
b)	Chemical Composition Tests			
		a) Magnesia percentage by mass Max. 6%		Review of MTCC only
		b) Insoluble material, percentage by mass x + 4 (100-x)/100 where x is the declared % of pozzolana in the PPC		-Do-
		c) Total sulphur content calculated as sulpuric anhydride (SO_3), percentage by mass not more than 3.0		-Do-
		Total loss on ignition shall not be more than 5 percent		

PINGGAO GROUP CO., LTD., China	
Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Annex-2

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR REINFORCEMENT STEEL AS PER IS 1786-1985 Edition-4.3 (2004-12)

S. N.	Name of the Test	Fe 415	Fe 500
i)	Chemical Analysis Test		
	Carbon	0.30 Percent Maximum	0.30 Percent Maximum
	Sulphur	0.060 Percent Maximum	0.055 Percent Maximum
	Phosphorus	0.060 Percent Maximum	0.055 Percent Maximum
	Sulphur & Phosphorus	0.11 Percent Maximum	0.105 Percent Maximum
ii)	Physical Tests		
	a) Tensile Strength Minimum	10% more than actual 0.2% proof stress but not less than 485 N/Sq mm.	8 % more than actual 0.2% proof stress but not less than 545 N/Sq.mm
	b) 0.2% of proof stress/Yield stress Minimum, N/mm²	415	500
	c) Elongation percent, Minimum	14.5	12
iii)	Bend & Re-bend Tests	Pass	Pass

PINGGAO GROUP CO., LTD., China	
Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Annex-3

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR COARSE AGGREGATES AS PER IS 383

3.	Coarse Aggregates										
i)	Physical Tests										
	a) Determination of Particles Size	a. IS Sieve Designation	%age passing for Single-Sized Aggregate of Nominal Size					Percentage Passing for grades Aggregate of Nominal Size			
			40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
		63 mm	100	-	-	-	-	-	-	-	-
		40 mm	85 to 100	100	-	-	-	95 to 100	100	-	-
		20 mm	0 to 20	85 to 100	100	-	-	30 to 70	95 to 100	100	100
		16 mm	-	-	85 to 100	100	-	-	-	90-100	-
		12.5 mm	-	-	-	85 to 100	100	-	-	-	90 to 100
		10 mm	0 to 5	0 to 20	0 to 30	0 to 45	85 to 100	10 to 35	25 to 55	30 to 70	40 to 85
		4.75 mm	-	0 to 5	0 to 5	0 to 10	0 to 20	0 to 5	0 to 10	0 to 10	0 to 10
		2.36 mm	-	-	-	-	0 to 5	-	-	-	-
	b. Combined Flakiness Index and Elongation Index		Not to exceed 40%								
	c. Crushing Value		Not to exceed 45%								
	d. Presence of Deleterious Material		Total presence of deleterious materials not to exceed 5%								
	e. Hardness		Abrasion value not more than 50%, Impact value not more than 45%								
	f. Soundness Test (for concrete work subject to frost action)		12% when tested with sodium sulphate and 18% when tested with magnesium sulphate								

Annex-4

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR FINE AGGREGATES AS PER IS 383

4.	Fine aggregates				
i)	Physical Tests	IS Sieve Designation	Percentage Passing for Graded Aggregate of Nominal Size		
	a) Determination of Particle Size		F.A. Zone I	F.A. Zone II	F.A. Zone III
		10 mm	100	100	100
		4.75 mm	90-100	90-100	90-100
		2.36 mm	60-95	75-100	85-100
		1.18 mm	30-70	55-90	75-100
		600 microns	15-34	35-59	60-79
		300 microns	5 to 20	8 to 30	12 to 40
		150 microns	0-10	0-10	0-10
	b) Silt Content		Not to exceed 8%	Not to exceed 8%	Not to exceed 8%
	c) Presence of Deleterious Material	Total presence of deleterious materials shall not exceed 5%			
	d) Soundness Applicable to Concrete Work Subject to Frost Action	10% when tested with sodium sulphate and 15% when tested with magnesium sulphate			

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Annex-5

ACCEPTANCE CRITERIA AND PERMISSIBLE LIMITS FOR CONCRETE WORK

1)	Concrete	a) Workability	Slump shall be recorded by slump cone method and it shall between 25-75 mm, depending upon workability requirement as per IS 456. 2000, reaffirmed 2016.
		b) Compressive strength	For Design mix as per IS:456 for Grade M15 or above. For nominal (volumetric) concrete mixes compressive strength for 1:1.5:3 (Cement : Fine aggregates : Coarse aggregates) concrete 28 days strength shall be min 265Kg/cm² and for 1:2:4(Cement: Fine Aggregate: Coarse aggregate) nominal mix concrete 28 days strength shall be min 210Kg/cm².

Notes:

1) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTHS FOR DESIGN MIX CONCRETE: As per clause 5.4.10.4 of CPWD Specifications, Volume I
   - (a) The average of the strength of three specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.
   - (b) If the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.
   - (c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.
   - (d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate after reconfirmation by NDT/Core test on the location portion represented by the cube samples.
   - (e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-Charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of conductor. If, however the Engineer-in-Charge so desires, he may order additional tests to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the contractor.

2) 53 Grade cement shall be used after obtaining specific approval of the Engineer in charge.

3) Portland slag cement conforming to IS 455:2015 may be used as per Technical Specification

4) All Design Mix Concrete shall be as per IS 456:2000, reaffirmed 2016.

5) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTHS FOR DESIGN MIX CONCRETE: As per Table-11, Amendment No, 4 of IS 456:2000 as given below: Note sheet reference no. CC/FQA/CLA/MIX dated 08/12/16 approved by Competent Authority.

Specified Grade	Case No.	Sampling	Acceptance criteria for Mix Design as per IS 456:2000	Remarks
M 15 and above	A 1	Mean of Group of 4 non-overlapping consecutive test results.	Shall greater than or equal to fck +0.825 x established standard deviation (rounded off to nearest 0.5N/sq.mm)* Or Fck +3 N/sq. mm, whichever is greater.	≥ fck – 3 N/sq mm

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

	A 2.	Individual test result out of A 1.	Greater than or equal (fck +3) N/sq.mm	Out of four non-overlapping consecutive test results, one individual test result only.
	B 1.	Group of non-overlapping consecutive if test results are less than 4	fck + 4, N/sq.mm, minimum	
	B 2.	Individual test result out of B 1.	fck -2, n/sq.mm, minimum	Out of less than four non-overlapping consecutive test results, one individual test results only.
	C 1.	When number of sample is only one.	fck – 4, N/sq.mm, minimum	

* Established value of standard deviation shall be determined based on Note of Table-11 of IS: 456.

Annex- 6

(Sheet 01 0f 02)

SAMPLING PLAN FOR BRICK-WORK

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Scale of sampling and permissible number of defectives for visual and dimensional characteristics. As per IS Standard

No of Bricks in the lot	For characteristics specified for individual bricks		For Dimensional characteristics for group of 20 bricks- No of bricks to be selected
	No of bricks to be selected	Permissible no of defective in the sample.	
(1)	(2)	(3)	(4)
2001-10000	20	1	40
10001-35000	32	2	60
35001-50000	50	3	80

Note: For a particular work where less then 5000 nos. of bricks are to be used, only visual checks are to be done.

Scale of sampling for physical characteristics

Lot size	Sampling size for compressive strength water absorption and efflorescence	Permissible No of defectives for efflorescence
(1)	(2)	(3)
2001-10000	5	0
10001-35000	10	0
35001-50000	15	1

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Annex- 6
(Sheet 02 0f 02)

ACCEPTABLE CRITERIA FOR BRICK WORK

1) Dimensional Tolerances: The dimensions of modular/ Non modular bricks when tested shall be within the following limits per 20 bricks.

S.N	DESCRIPTION	MODULAR BRICKS	NON-MODULAR BRICKS
1	LENGTH	372 t0o 388 cm (380± 8 cm)	432 to 468 cm (450 ± 18)
2	WIDTH	176 to 184 cm (180± cm)	213 to 231cm (222± 9)
3	HEIGHT	176 to 184 cm (180± 4 cm)	134 to 146 cm (140 ± 6)

2) Compressive strength: the bricks shall have a minimum average compressive strength as specified in CONTRACT TECHNICAL specification. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. in case compressive strength of any individual brick tested exceeds the upper limit specified for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified for the purpose of calculating the average compressive strength.

3) Water absorption: The average water absorption of bricks shall not be more than 20% by weight.

4) Efflorescence: The rating of efflorescence of bricks shall not be more than moderate.

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

Annex- 7(Page 1 of 1)

TESTING FOR TERRAZZO TILES
As per IS Standard

S.N.	Frequency of Testing	Minimum Quantity of Material for Carrying Out Test
1.	One test for every10000 nos. or part thereof for each type and size from a single manufacturer.	5000nos. (no testing need be done if total number tiles of all the types of all sizes from all manufacturers used in a work is less than 5000)

TABLE – I: SAMPLING FREQUENCY FOR BARDED WIRE

S.N.	NUMBER OF REELS IN THE LOT	NO. OF REELS TO BE SELECTED FOR SAMPLING
1.	UPTO 25	3
2.	26 TO 50	4
3.	51 TO 150	5
4.	151 TO 300	7
5.	301 AND ABOVE	10

TABLE – II: ACCEPTABLE TENSILE PROPERTIES AS PER IS 278

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

S. NO.	SIZE OF LINE WIRE (MM)	TENSILE STRENGTH OF LINE WIRE N/SQ.MM	MINIMUM BREAKING LOAD OF COMPLETED BARBED WIRE (KN)
1.	2.50	390 TO 590	3.7
2.	2.24	390 TO 590	3.0

Annexure-8
Page 1 of 2

PHYSICAL REQUIREMENT OF COARSE AGGREGATE

S. No.	Type of Construction.	Type of W.B.M.	Test Method	Requirements
1.	Sub-base	Los Angeles Abrasion Value or Aggregate Impact value	IS:2386(Pt. IV) IS:2386 (Pt. IV) IS:5640***	60% max. * 50% max
2.	Base	a) Los Angeles Abrasion Value or Aggregate Impact value b) Flakiness Index	IS:2386(Pt. IV) IS:2386 (Pt. IV) IS:5640*** IS:2386 (Pt. I)	50% max. * 40% max **15% max
3.	Surface Course	a) Los Angeles Abrasion Value or Aggregate Impact value b) Flakiness Index	IS:2386(Pt. IV) IS:2386 (Pt. IV) IS:2386 (Pt .I)	40% max. 30% max 15% max
4.	Binding Material	Plasticity index	IS :2720 (Pt V)	Less than 6

* Aggregates may satisfy requirements of either of the two tests.

** The requirements of flakiness index shall be enforced only in case of crushed/broken stone and crushed slag.

***Aggregates like brick metal, kankar and laterite which get softened in presence of water, shall be tested for impact value under wet conditions in accordance with IS:5640.

Annexure-8

Page 2 of 2

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

GRADING REQUIREMENTS OF COARSE AGGREGATE FOR W.B.M (As per IS Standard)

Grading No.	Size Range	Sieve designation	% by weight passing the sieve
1.	90mm to 45mm (Suitable for sub base courses of compacted layer of not less than 100mm thickness).	125mm 90mm 63mm 45mm 22.4mm	100 90-100 25-60 0-15 0-5
2.	63mm to 45mm	90mm 63mm 53mm 45mm 22.4mm	100 90-100 25-75 0-15 0-5
3.	53mm to 22.4mm	63mm 53mm 45mm 22.4mm 11.2mm	100 95-100 65-90 0-10 0-5
4.	Screening		
	A) 13.2 mm	13.2 mm 11.2 mm 5.6 mm 180 micron	100 95-100 15-35 0-10
	B) 11.2 mm	11.2 mm 5.6 mm 180 micron	100 90-100 15-35

General Notes: -

1) This standard Field Quality Plan is not to limit the supervisory checks which are otherwise required to be carried out during execution of work as per drawings/Technical specifications etc.
2) Contractor shall be responsible for implementing/documenting the SFQP. Documents shall be handed over by the contractor to OWNER after the completion of the work.
3) Project in charge means over all incharge of work. Site Incharge means incharge of the Site. Site Engineer means in charge of the section.
4) In case of deviation the approving authority will be one step above the officer designated for acceptance in this quality plan subject to minimum level of Site in charge. Site Engineer's responsibility may be allocated to Site JE, with the approval of Regional Head, only in such cases where, Site Engineer is not in position.
5) Acceptance criteria and permissible limits for tests are indicated in the Annexures. However, for further details/tests CONTRACT TECHNICAL specification and relevant Indian standards shall be referred.
6) Tests as mentioned in this FQP shall generally be followed. However, E.I.C. reserves the right to order additional tests wherever required necessary at the cost of the agency.
7) All counter checks/tests by OWNER shall be carried out by OWNER's officials at least at the level of Site Engineer.

PINGGAO GROUP CO., LTD., China

Consultant	Powergrid, India
Works	Switchyard Civil Works
Project	Kathmandu Valley Transmission Capacity Reinforcement Project (KTCEP)
Date of Issue	12.09.2019
Validity	Till next revision

FIELD QUALITY PLAN (FQP)

FQP No.	DOC NO. Pinggao/KTCEP/FQP/02
REV.	R02

8) Main producer of reinforcement steel means SAIL, RINL, TATA STEEL, ISCO, JSPL, JSW etc. or approved manufacturer (to be approved by owner) who are using Billets of Main Producer i.e. SAIL, RINL, TATA STEEL, ISCO, JSPL, JSW etc. The authorized dealer means the dealer whose names are listed in the main producer's web site or certified by the main producers.

9) Wherever CTD bars (Fe-415) are specified for reinforcement steel, TMT reinforcement steel are acceptable if the physical, chemical & Mechanical properties of TMT reinforcement meet the minimum requirement of CTD bars.

10) Accepting Authority for testing Laboratory shall be Site in Charge.

11) Mobile testing Labs owned by the contractor may also be acceptable if their facilities meet the testing requirements and the testing equipments are properly calibrated subject to approval of project In-charge.

12) READYMIX CONCRETE (RMC) IS ACCEPTABLE FOR USE. HOWEVER, SITE INCHARGE SHALL APPROVE THE SOURCE OF MATERIALS TO BE USED FOR RMC. The documentation to be maintained shall be as per IS 4926:2003 i.e. i) Information to be supplied by the purchaser (clause 7)

ii) Information to be supplied by the producer (clause 8)

iii) Sampling for concrete strength should be one set of 3 nos. of cubes for every 20 cu.m or part thereof for each day of concreting and 28 days compressive strength shall be tested in line with IS:456.

13) Epoxy coating on reinforcement steel wherever required shall be done as per IS 13620.

14) Refer CPWD Specification for items not included in this SFQP for mandatory testing.

15) A source of material for aggregate (course & fine), bricks, masonry stone, structural steel and cement once approved for a work in the project site, same shall be considered as an approved source for other works also, if there is no change in quarry, supplier source.

16) All the charges in connection with NDT/Core Tests shall be borne by the Contractor.

17) In case Reinforcement Steel is procured from other approved manufacturer (other than main producers), as mentioned in compendium of vendors, OWNER shall select the samples from offered lot at their factory / stock yard and witness tests at their factory / third party lab. (TPL) approved by Owner, as per IS: 1786 (latest revision).

18) Cement is to be used in the order it is delivered (i.e. First in First Out). Cement bought to works shall not be more than 6 weeks old from the date of manufacture.in case the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected, if it fails to conform to any of the requirements given in the relevant Indian Standard. Cement shall be packed in bags and stored in accordance with the provisions in IS -4082.

Appendix C: Checklist

FIELD OBSERVATION CHECKLIST (Civil Works - FQP Based)

Project Name:	
Location:	
Date:	
Observed by:	

1. General / Pre-Construction

S.N	Item	Yes	No	Remarks
1	Approved drawings available at site	■	■	
2	Latest revision drawings used	■	■	
3	Method statement approved	■	■	
4	FQP / ITP available at site	■	■	
5	Equipment calibration records available	■	■	

2. Material Quality - Cement

S.N	Item	Yes	No	Remarks
1	Approved brand used	■	■	
2	Stored in dry condition	■	■	
3	No lumps present	■	■	

Material Quality - Aggregates

S.N	Item	Yes	No	Remarks
1	Clean and free from impurities	■	■	
2	Proper grading maintained	■	■	

Material Quality - Reinforcement Steel

S.N	Item	Yes	No	Remarks
1	Correct grade used	■	■	
2	Free from rust/oil	■	■	
3	Proper storage above ground	■	■	

3. Reinforcement Work

S.N	Item	Yes	No	Remarks
1	Bar bending as per BBS	■	■	
2	Spacing as per drawing	■	■	
3	Lapping length adequate	■	■	
4	Cover blocks provided	■	■	
5	Binding properly done	■	■	
6	Inspection Request (IR) raised	■	■	

4. Formwork

S.N	Item	Yes	No	Remarks
1	Alignment and level correct	■	■	
2	Supports and bracing adequate	■	■	
3	No leakage gaps	■	■	
4	Surface cleaned	■	■	
5	Release agent applied	■	■	

5. Concrete Work

S.N	Item	Yes	No	Remarks
1	Mix design approved	■	■	
2	Proper batching method used	■	■	
3	Slump test conducted	■	■	
4	Cube samples taken	■	■	
5	Proper vibration done	■	■	
6	Layer thickness maintained	■	■	

6. Curing

S.N	Item	Yes	No	Remarks
1	Curing started timely	■	■	
2	Proper method used	■	■	
3	Duration maintained	■	■	

7. Earthwork & Compaction

S.N	Item	Yes	No	Remarks
1	Layer thickness controlled	■	■	
2	Moisture content checked	■	■	
3	Compaction test conducted	■	■	
4	Test frequency as per FQP	■	■	
5	Required density achieved	■	■	

8. Masonry Work

S.N	Item	Yes	No	Remarks
1	Brick/block quality acceptable	■	■	
2	Mortar ratio maintained	■	■	
3	Alignment and verticality proper	■	■	
4	Joint thickness uniform	■	■	

9. Documentation & QA/QC

S.N	Item	Yes	No	Remarks
1	Inspection Requests (IR) maintained	■	■	
2	Test reports available	■	■	
3	Checklist signed before next activity	■	■	
4	NCR issued (if required)	■	■	
5	Corrective actions implemented	■	■	

Overall Observation Summary

Observer: ____________________ Contractor Rep: ____________________ Consultant Rep: ____________________

Appendix D: Field Observation

Figure: Site Observation at Lapsiphedi SS.

Figure: Site Observation at Lapsiphedi SS.

Figure : Site Observation At Thimi SS.

Figure : Site Observation At Changu SS.

Annexure A

[IOEGC18] Editor Decision

2026-04-21 01:22 PM

Rabin Dhakal:

We have reached a decision regarding your submission to 18th IOE Graduate Conference, "Analyzing Implementation of Quality Assurance and Quality Control Measures in an ADB-Funded Gas Insulated Substation(GIS) With In kathmadnu Valley: A Case Study of Lapshiphedi 220kV GIS Substation".

Our decision is to: Accept Submission

With Warm Regards,
IOEGC-18 Editorial Team

Annexure B

iThenticate — Similarity Report ID: oid:3117:584993050

9	friendlyturtles.com Internet	<1%
10	repository.amref.ac.ke Internet	<1%
11	scholar9.com Internet	<1%
12	ir.csuc.edu.gh:8080 Internet	<1%
13	journals.chroniva.org Internet	<1%
14	repository.smuc.edu.et Internet	<1%
15	researchgate.net Internet	<1%
16	eprints.qut.edu.au Internet	<1%
17	theacademic.in Internet	<1%
18	elibrary.tucl.edu.np Internet	<1%
19	mdpi.com Internet	<1%
20	stmlportal.net Internet	<1%

iThenticate **Similarity Report ID:** oid:3117:584993050

4% Overall Similarity

Top sources found in the following databases:

- 4% Internet database
- 1% Publications database
- Crossref database
- Crossref Posted Content database
- 0% Submitted Works database

TOP SOURCES

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	bspace.buid.ac.ae Internet	<1%
2	joi.or.jp Internet	<1%
3	elibrary.tucl.edu.np:8080 Internet	<1%
4	ijfmr.com Internet	<1%
5	ucudir.ucu.ac.ug Internet	<1%
6	unbscholar.lib.unb.ca Internet	<1%
7	cfbsjs.usask.ca Internet	<1%
8	ijmedph.org Internet	<1%

iThenticate

Similarity Report ID: oid:3117:584993050

PAPER NAME

Analysing Implementation of Quality Assurance and Quality Control Measures in an ADB-Funded GIS Substation within Kathmandu valley

AUTHOR

Rabin Dhakal

WORD COUNT

9887 Words

CHARACTER COUNT

56821 Characters

PAGE COUNT

58 Pages

FILE SIZE

1.4MB

SUBMISSION DATE

Apr 30, 2026 10:49 PM GMT+5:45

REPORT DATE

Apr 30, 2026 10:50 PM GMT+5:45

4% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 4% Internet database
- 1% Publications database
- Crossref database
- Crossref Posted Content database
- 0% Submitted Works database

Excluded from Similarity Report

- Bibliographic material
- Quoted material
- Cited material
- Small Matches (Less then 10 words)