



Communication Barriers, Project Communication Quality, and Multi-Project Management Effectiveness in Single-Consultant Parallel Construction Supervision: A SEM-PLS and IPMA Approach

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Abstract

Background: Managing multiple construction projects under a single construction management consultant requires effective communication and coordination among stakeholders. Communication barriers may reduce project communication quality and multi-project management effectiveness.

Objective: This study aims to identify relevant communication barriers, examine their effects on project communication quality and multi-project management effectiveness, investigate the mediating role of project communication quality, and determine priorities for communication improvement.

Methods: A quantitative approach supported by expert validation was employed. Data were collected from 80 purposively selected respondents across 32 construction projects. Eight communication barrier factors were identified through a literature review and initial expert validation. Data were analyzed using partial least squares structural equation modeling (PLS-SEM) and importance-performance map analysis (IPMA), followed by final expert validation.

Results: Five of the 25 hypotheses were supported. Information Delay (X1) and Communication Media Mismatch (X3) negatively affected Project Communication Quality ($\beta = -0.123, p = 0.045$; $\beta = -0.583, p = 0.021$). Information Ambiguity/Inaccuracy (X2) negatively affected Multi-Project Management Effectiveness ($\beta = -0.249, p = 0.033$). Project Communication Quality positively affected Multi-Project Management Effectiveness ($\beta = 0.807, p = 0.002$) and mediated the effect of Information Delay ($\beta = -0.088, p = 0.016$).

Conclusion: Project Communication Quality is central to Multi-Project Management Effectiveness. Improvement priorities include strengthening communication quality, reducing information delays and ambiguity, and ensuring the appropriate selection and use of communication media.

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INTRODUCTION

The development of national strategic areas is one of the Indonesian government's major efforts to promote equitable development and economic growth beyond major government centers. National-scale construction projects generally involve numerous stakeholders, including project owners, planning consultants, main contractors, subcontractors, and material suppliers. The complexity of interorganizational structures makes communication and coordination critical determinants of project success (Aziz et al., 2022). Communication is a vital element of construction projects because it helps establish a shared understanding among stakeholders, supports decision-making, and ensures the smooth execution of technical and administrative activities (Ahmed & Jawad, 2022; Malik et al., 2021).

Within the organizational structure of national-scale construction projects, a Construction Management Consultant (CMC), known in the Indonesian context as *Konsultan Manajemen Konstruksi* (KMK), is responsible for monitoring quality, schedule performance, and overall coordination across work packages. The involvement of a CMC is necessary because a supervision scheme in which each work package is managed separately may not adequately facilitate cross-project integration during the early stages of regional development. However, when a single CMC must supervise multiple projects running in parallel, each with its own teams, documentation, and information flows, communication challenges become more pronounced. Differences in reporting standards, data formats, and approval workflows across projects can lead to information inconsistencies, coordination failures, overlapping activities, and unsynchronized decisions among projects (Suwandari & Suratkon, 2026).

A major problem that frequently arises in large-scale construction projects is ineffective communication, characterized by delays in information delivery and misalignment among stakeholders' perceptions. Communication problems in construction projects generally stem from issues involving timeliness, accuracy, media suitability, information overload or underload, and procedural barriers (Aziz et al., 2022). Information delays often occur because information must pass through multiple organizational levels before reaching the relevant parties, creating time lags that slow decision-making concerning design changes, work instructions, and technical clarifications (Suleiman, 2022). Inaccurate or delayed information can also create differences in perception among stakeholders. Information distortion and divergent interpretations of instructions are major triggers of miscommunication, potentially leading to conflicts, work delays, and increased supervision costs (Suleiman, 2022). These findings are reinforced by evidence that information that is not communicated promptly and clearly can undergo substantial changes in meaning as it passes between organizational levels, particularly in hierarchical project structures such as those involving CMCs (Suleiman, 2022).

A further consequence of miscommunication is the emergence of technical problems during construction, including design clashes, overlapping activities, and rework. Technical miscommunication arising from incomplete documentation or unclear instructions is one of the major causes of rework in construction projects (Rahimian et al., 2022). Similarly, inconsistencies between design information and construction activities can cause interdisciplinary clashes when information is not updated consistently across project teams (Yang et al., 2025). In the development area examined in this study, multiple projects are executed concurrently, involving numerous stakeholders. Although Building Information Modeling (BIM) has been adopted as a supporting tool for coordination, field observations continue to reveal communication problems that trigger clashes during construction. Discrepancies between document and model versions used by different stakeholders, delays in communicating design revisions or meeting decisions, and unclear approval workflows and information responsibilities can result in field teams receiving inconsistent or untimely information. These conditions directly affect schedule performance, cost efficiency, and construction quality, consistent with findings that communication effectiveness substantially influences coordination quality, rework levels, and synchronization among project activities (Manuputty & Nursin, 2023). In multi-project environments, ineffective communication can produce a domino effect in which problems in one project affect the schedules or decisions of other projects within the same development area or CMC assignment. Technologies such as the Common Data Environment (CDE) and BIM can facilitate integrated communication and project coordination. However, the primary challenge

lies not only in technology adoption but also in maintaining consistent procedures, fostering an effective communication culture, and ensuring that personnel have the competencies required to operate integrated communication systems across projects ([Likita et al., 2025](#)).

Conceptually, communication management is one of the most critical elements of construction project management because construction projects involve multiple parties with diverse roles, competencies, and interests. Communication has been described as the "lifeline" of a construction project because it determines the quality of stakeholder relationships and the effectiveness of decision-making ([Ahmed & Jawad, 2022](#); [Malik et al., 2021](#)). Furthermore, project management failures in developing countries are often attributable to weak communication management rather than solely to technical deficiencies ([Al-Otaibi et al., 2025](#); [Lubis, 2021](#)). Formal communication in construction projects occurs through documents such as progress reports, Requests for Information (RFIs), change instructions, meeting minutes, revised drawings, and contractual correspondence. Informal communication, by contrast, includes on-site exchanges and spontaneous discussions at the construction site. Project communication quality is strongly influenced by message clarity, timeliness, media suitability, information completeness, and the availability of feedback mechanisms. When any of these elements is inadequate, uncertainty, miscommunication, and conflict may arise ([Aziz et al., 2022](#)).

In addition to these five categories of communication barriers, project management standards emphasize the importance of formal communication planning. Such planning establishes stakeholder information requirements, distribution methods and frequencies, communication responsibilities, and escalation mechanisms as part of the project communication management process ([Institute, 2021](#); [Project Management Institute, 2025](#)). The absence of a formal communication plan, or a lack of clarity in its provisions, can increase the risks of delays, ambiguity, and inconsistencies across the communication channels and media discussed previously. Consequently, communication planning is also a relevant dimension to examine when investigating barriers in multi-project environments.

Sources of communication problems in construction projects can be classified into several categories: information delays, unclear or inaccurate information, mismatches between communication media and their intended purposes, information overload or underload, and procedural or structural barriers ([Aziz et al., 2022](#)). Ambiguous work instructions, incomplete drawings, and inadequately documented design changes can trigger miscommunication ([Ahmed & Jawad, 2022](#); [Malik et al., 2021](#)). Moreover, when information is transmitted between organizational levels without a standardized format, distortions in meaning can occur ([Aziz et al., 2022](#)). Beyond these five categories, inadequate or inconsistent communication frequency, communication that occurs only when problems arise, and the absence of a formal communication plan governing communication channels, responsible personnel, media, schedules, document formats, and escalation mechanisms constitute additional barriers to multi-project implementation. The use of inappropriate communication media (for example, submitting revised drawings through group chats without attaching the corresponding official documents) further increases the potential for technical misinterpretation ([Yang et al., 2025](#)).

Project communication quality reflects the extent to which communication among stakeholders is clear, complete, timely, relevant, interpretable, and consistently understood. It encompasses message clarity, information completeness, timeliness, relevance, two-way feedback, and stakeholder participation ([Ahmed & Jawad, 2022](#); [Malik et al., 2021](#)). High-quality communication enables stakeholders to interpret information consistently without requiring extensive additional clarification ([Al-Otaibi et al., 2025](#); [Lubis, 2021](#)). Two-way communication also plays an important role in resolving technical problems, particularly when projects encounter unexpected site conditions ([Soomro et al., 2024](#)). Furthermore, active stakeholder participation in communication processes promotes goal alignment and reduces internal conflicts ([Yalçın, 2022](#)). Project management effectiveness refers to the extent to which a project achieves its targets for time, cost, quality, and occupational safety ([Susilotomo, 2026](#)). Effective communication is a key determinant of schedule performance because many project delays originate from miscommunication among stakeholders ([Muhaemin & Suroso, 2025](#)). Project management effectiveness is also reflected in smooth coordination among stakeholders, reduced rework, and the team's ability to manage conflicts appropriately ([Manuputty & Nursin, 2023](#)), as

well as stakeholder satisfaction with overall project implementation performance (Azman et al., 2025). At the organizational level, where multiple projects are managed simultaneously, cross-project integration the ability to connect data, processes, and management standards within a common system framework is both a challenge and a necessity in modern construction management (Bosfield et al., 2026). Standardized operating procedures, reporting formats, and communication protocols facilitate organizational control, benchmarking, and performance evaluation across projects (Althoey et al., 2024).

Several previous studies have examined communication in construction projects from different perspectives. Suleiman (2022) analyzed the causes and consequences of poor communication in the construction industry in the Middle East and North Africa (MENA) region and found that information delays, mismatches in communication media, and inaccurate information were major causes of conflict and rework. However, the study was limited to a single geographical region and did not address multi-project environments. Rahimian et al. (2022) developed a model for predicting construction project communication quality using a deep neural network approach and concluded that clarity and timeliness were the primary determinants of communication quality. However, their study did not assess the social and behavioral aspects of communication in depth. Muhaemin & Suroso (2025) analyzed the influence of project communication management on the speed of owner decision-making in multi-story building projects and found a significant relationship. Nevertheless, their research was limited to a single high-rise building project. Likita et al. (2025) compiled and validated guidelines for integrating BIM and Lean Construction to improve coordination and transparency and reduce rework, but these guidelines had not been tested in actual project implementation. Azman et al. (2025) identified and analyzed the communication factors that most strongly influenced project success using linear regression and found that information accuracy and communication timeliness were the most influential factors. However, the study focused on a single area and did not examine multi-project systems. Several other studies, including those by Peli et al. (2022), Manuputty & Nursin (2023), and Damanik et al. (2021), also emphasized the importance of communication in construction project performance from the perspectives of two stakeholder groups. However, these studies remained limited to communication assessment within individual projects.

Other studies have further advanced the understanding of communication in construction projects across different institutional contexts. Ibdyanti (2023) examined the relative importance of factors influencing the integration of communication management in construction projects in Banda Aceh City and found that integrating communication channels among stakeholders was the most influential factor in achieving successful integration. Jaya et al. (2023) examined construction project communication management during the COVID-19 pandemic and demonstrated that restrictions on face-to-face interactions increased the risk of information delays and ambiguity. Mareno et al. (2022) analyzed the relationship between project communication factors and on-time performance in Banda Aceh City and found a significant association between communication and timely project completion. Meanwhile, Prasasto & Putra (2024) demonstrated that communication factors also influenced risk levels in multi-story building projects. Riyadi et al. (2023) investigated the management of leaders' interpersonal communication in fostering employee cohesion within construction companies, whereas Saputro (2024) analyzed the causal relationships associated with ineffective communication in construction projects using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach, similar to the method employed in the present study, but within a single-project context. Trisnaningati et al. (2024) also emphasized the influence of communication management on the smooth implementation of project activities. Regarding technology and knowledge utilization, Li et al. (2022) found that information and knowledge sharing improved project performance through the mediating role of trust between stakeholders. Amaechi et al. (2025), through a systematic literature review, showed that cross-project knowledge management continued to face barriers related to the culture of information sharing. Juhanda et al. (2026) found that communication management significantly influenced project performance in construction contractor companies. Collectively, these studies consistently demonstrate the central role of communication in project performance. However, almost all were conducted within the context of a single project or a single construction company and therefore did not explain how

communication barriers manifest when one supervisory entity must manage multiple projects running concurrently within the same development area.

Based on a review of previous studies, the existing literature tends to focus on one of three areas: communication analysis within individual projects, the influence of communication on project performance in terms of time, quality, and cost, or the application of communication technologies and knowledge-sharing practices in construction projects. To the best of the authors' knowledge, the literature reviewed for this study revealed no research that specifically examined the effectiveness of communication and coordination systems across multiple projects executed simultaneously within a single development area, with particular attention to the strategic role of Construction Management Consultants as central coordinators of cross-project information management. Similarly, no study was identified that developed an integrated communication framework accounting for interactions among contractors, owners, CMCs, and other stakeholders within a complex supervision environment. Beyond their focus on individual projects, previous studies share a conceptual and methodological limitation: communication is generally treated as a direct determinant of project performance, while Project Communication Quality is rarely modeled explicitly as a mediating mechanism linking specific communication barriers to multi-project management effectiveness. The novelty of this study lies in developing an integrative approach that directly connects communication and coordination effectiveness with supervisory performance across multiple construction projects within a single national development area. The approach combines a literature review, preliminary expert validation, PLS-SEM modeling, Importance-Performance Map Analysis (IPMA), and final expert validation within a complementary analytical framework. More specifically, the novelty lies not in the combination of methods itself but in positioning Project Communication Quality as the mediating mechanism that explains how specific communication barriers, particularly information delays, affect multi-project management effectiveness under a single supervisory entity.

This study specifically examines how communication and coordination barriers manifest when a single Construction Management Consultant coordinates multiple construction projects executed concurrently within a single national development area. Accordingly, the objectives of this study are to: (1) identify and analyze the dominant communication barriers affecting multi-project implementation within the supervision scope of Construction Management Consultant X; (2) analyze the effects of communication barriers on Project Communication Quality and the effect of Project Communication Quality on multi-project management effectiveness; and (3) determine priorities for communication improvement based on the importance and performance of communication barrier factors, with the aim of enhancing multi-project management effectiveness within the supervision scope of Construction Management Consultant X.

Academically, this study contributes to knowledge of project communication management by positioning Project Communication Quality as a mediating construct that explains the mechanism linking communication barriers to multi-project management effectiveness, a relationship that has rarely been modeled explicitly in multi-project supervision contexts. Practically, the findings are expected to assist organizations managing multiple construction projects simultaneously, particularly Construction Management Consultants, in prioritizing communication improvement strategies and allocating limited coordination resources to the barriers that have the greatest influence on performance.

METHOD

This study employed a quantitative approach supported by expert validation, with the analytical stages structured around three research questions. The first stage involved a literature review and preliminary expert validation to identify relevant communication barriers in a multi-project context. The second stage involved Structural Equation Modeling-Partial Least Squares (SEM-PLS) analysis to examine the effects of communication barriers on Project Communication Quality and the effect of Project Communication Quality on Multi-Project Management Effectiveness. The third stage involved Importance-Performance Map Analysis (IPMA) to determine priorities for communication improvement. The fourth and final stage involved expert validation to confirm the consistency of the research findings with actual field implementation conditions.

The research variables were developed based on a literature review, preliminary observations, and preliminary expert validation of the research instrument. This study identified eight communication barrier variables as independent variables (X): Information Delay (X1), Information Ambiguity/Inaccuracy (X2), Communication Media Mismatch (X3), Information Overload/Underload (X4), Procedural/Structural Barriers (X5), Differences in Perception Between Stakeholders (X6), Inadequate Communication Frequency (X7), and Unclear Communication Plan (X8). Project Communication Quality was designated as the mediating variable (Z), while Multi-Project Management Effectiveness was designated as the dependent variable (Y). The X variables were operationalized as barrier constructs, such that higher scores indicated greater perceived communication barriers. In contrast, Z and Y were operationalized as positive constructs, such that higher scores indicated better communication quality and greater management effectiveness. Each variable was measured using several indicators adapted from relevant literature. For example, X1 was measured using indicators related to delays in information delivery and the speed of information distribution Suleiman (2022) and Aziz et al. (2022); X2 included indicators related to ambiguity in work instructions and consistency in document revisions Malik et al. (2021) and Suleiman (2022); and X3 included indicators related to the suitability of communication media for technical visualization (Yang et al., 2025). These indicators underwent preliminary expert validation before being incorporated into the questionnaire.

Before the questionnaire was distributed to the main respondents, preliminary expert validation was conducted to assess content relevance, editorial clarity, and the suitability of each questionnaire item. Three experts participated in the validation process. They met the following criteria: at least 10 years of professional experience in construction or project management, a position at or above the project manager or team leader level with project decision-making authority, and experience in supervising or managing multiple construction projects. The experts comprised a team leader and an owner's director, both with more than 20 years of professional experience and master's degrees, as well as a practitioner-lecturer with a doctoral degree. Based on the preliminary expert validation results, several indicators considered insufficiently relevant to the multi-project context were eliminated before the final instrument was used for data collection.

The research population comprised all stakeholders involved in communication and coordination across 32 projects under the supervision of Construction Management Consultant X. These stakeholders included Commitment-Making Officials (Pejabat Pembuat Komitmen, PPK)/owner representatives, supervisory consultants, implementing contractors, and representatives of KMK X, with a total population of 100 individuals. Purposive sampling was used to select respondents based on their direct involvement in project communication and coordination, experience spanning at least one period of significant project activities, and understanding of formal and informal communication flows within the project environment. The sample size was calculated using Slovin's formula with a 5% margin of error, yielding 80 respondents from the population of 100 individuals. The collected data were subsequently analyzed using PLS-SEM. Given the relatively limited sample size in relation to the number of constructs and structural relationships examined, the statistical findings were interpreted cautiously, and sample size was acknowledged as a limitation of the study.

The research instrument took the form of a questionnaire using a five-point Likert scale, ranging from 1 to 5. Items measuring the X variables were formulated in the direction of communication barriers, with higher scores indicating stronger perceived barriers, whereas items measuring Z and Y were formulated in a positive direction, with higher scores indicating better communication quality and greater management effectiveness. Each X variable was operationalized using three to five questionnaire items. For example, X1 (Information Delay) was measured using five items covering information delivery delays, stakeholder response times, information distribution speed, and the alignment of communication with coordination schedules. The mediating variable, Z (Project Communication Quality), was measured using ten items covering message clarity, information completeness, timeliness, relevance, two-way feedback, and consistency of understanding among stakeholders. The classification of communication barriers into eight distinct categories was consistent with the category-based approach to root

cause analysis commonly used in risk studies to facilitate the systematic identification of causes and the formulation of mitigation measures (Dharmawan, 2022). Primary data were obtained through questionnaire administration and expert validation, while secondary data were obtained from project documents, relevant regulations, and academic journals.

The PLS-SEM analysis was conducted using SmartPLS software in two main stages: measurement model (outer model) evaluation and structural model (inner model) evaluation. The outer model evaluation assessed convergent validity, using indicator loadings of at least 0.70 and an Average Variance Extracted (AVE) value of at least 0.50; discriminant validity, using cross-loadings, latent variable correlations, and the Fornell-Larcker criterion; and construct reliability, using Cronbach's alpha and composite reliability values of at least 0.70. Indicators that did not meet the loading criteria were removed iteratively, and the model was re-estimated until the remaining indicators satisfied the specified evaluation criteria. The inner model evaluation examined the coefficient of determination (R^2), tested hypotheses using bootstrapping, and assessed effect sizes (f^2) to determine the magnitude of each exogenous variable's contribution to the endogenous variables. A relationship was considered statistically significant when its t-statistic exceeded 1.96 or its p-value was below 0.05. Because the X variables represented communication barriers, negative path coefficients were expected for the relationships between X and Z and between X and Y, whereas a positive path coefficient was expected for the relationship between Z and Y.

IPMA was subsequently used as an extension of the PLS-SEM analysis to map the importance and performance of the relevant constructs in relation to two target constructs: Project Communication Quality (Z) and Multi-Project Management Effectiveness (Y). Because the X variables represented barriers, their performance scores were interpreted as indicators of the level of perceived barriers rather than as measures of positive performance. Accordingly, the interpretation of strategic priorities accounted for the direction of the relationships and used the absolute magnitude of importance to identify the contributions of communication barriers to the target constructs. The final research stage involved validation by the same three experts to assess whether the PLS-SEM and IPMA findings were consistent with the three research questions and the actual conditions of multi-project implementation in the field.

RESULTS AND DISCUSSION

Results

This study involved 80 respondents from 32 projects supervised by Construction Management Consultant X. The characteristics of the respondents are presented in Table 1.

Table 1

Respondent Characteristics

Characteristics	Categories	Number (People)	Percentage
Gender	Men	73	91%
	Women	7	9%
Age	31-40 years old	26	32%
	40-50 years	36	45%
	> 50 years	18	23%
Job Title/Position	Owner/PPK	12	15%
	Construction Management Consultant	38	47%
	Contractors	30	38%
Work Experience	5-10 years	20	25%
	10-15 years	38	47%
	> 15 years old	22	28%

Source: Primary data processed (2026)

As shown in Table 1, most respondents were male (91%; $n = 73$). Respondents aged 41–50 years constituted the largest age group (45%; $n = 36$), followed by those aged 31–40 years (32%; $n = 26$) and those over 50 years old (23%; $n = 18$). No respondents were under 30 years old. The largest proportion of respondents came from Construction Management Consultants (47%; $n =$

38), followed by contractors (38%; n = 30) and owners or *Pejabat Pembuat Komitmen* (PPK; 15%; n = 12). No subcontractors participated in the study. Regarding work experience, the largest group had 10–15 years of experience (47%; n = 38), followed by those with more than 15 years (28%; n = 22) and those with 5–10 years (25%; n = 20). No respondents had fewer than five years of work experience. This respondent profile indicates substantial professional experience and direct involvement in strategic positions within the project implementation structure. Consequently, the respondents' perceptions of communication and coordination barriers may reasonably reflect actual field conditions.

Results of Literature Review and Initial Expert Validation

The communication barrier factors examined in this study were not determined by ranking the mean questionnaire scores. Instead, they were identified through a literature review and confirmed through initial expert validation. The results are presented in Table 2.

Table 2

Results of Literature Review and Validation of Initial Experts on Communication Barriers Factors

Yes	Code	Inhibition Factor Variables	Literature Review Basics	Categories
1	X2	Ambiguity/Inaccuracy of Information	Suleiman (2022); Aziz et al. (2022)	Relevant; inappropriate indicators are eliminated before the main questionnaire
2	X1	Information Delay	Malik et al. (2021); Aziz et al. (2022)	Relevant; used as a dimension of communication barriers
3	X7	Inadequate Communication Frequency	Yang et al. (2025); Aziz et al. (2022)	Relevant; used as a dimension of communication barriers
4	X5	Procedural/Structural Barriers	Aziz et al. (2022); Amaechi et al. (2025)	Relevant; inappropriate indicators are eliminated before the main questionnaire
5	X6	Differences in Perceptions Between Stakeholders	; Aziz et al. (2022); Althoey et al. (2024)	Relevant; used as a dimension of communication barriers
6	X4	Information Overload/Underload	Peli et al. (2022); Malik et al. (2021)	Relevant; used as a dimension of communication barriers
7	X3	Communication Media Mismatch	Malik et al. (2021); Manuputty & Nursin (2023)	Relevant; inappropriate indicators are eliminated before the main questionnaire
8	X8	Unclear Communication Plan	Institute (2021) and Project Management Institute (2025); Jaya et al. (2023); Althoey et al. (2024)	Relevant; inappropriate indicators are eliminated before the main questionnaire

Source: Primary data processed (2026)

As shown in Table 2, eight communication barrier factors were identified as relevant to this study. These factors were derived from a synthesis of the literature and confirmed through initial expert validation, thereby addressing the first research question. Their selection was based on theoretical foundations and expert confirmation of their relevance to the conditions of parallel construction projects, rather than on the ranking of respondents' mean questionnaire scores. The questionnaire data were subsequently used for the PLS-SEM and IPMA analyses.

Evaluation of the Measurement Model (Outer Model)

The measurement model was evaluated in terms of convergent validity, discriminant validity, and construct reliability. Outer loadings were examined in stages. In the initial assessment, indicator Y2 had an outer loading of 0.018 and was therefore removed from the model. The remaining indicators met the minimum outer-loading criterion of 0.70. Following the removal of Y2, all constructs had average variance extracted (AVE) values above 0.50, ranging from 0.988 to 1.000 (Table 3). These results indicate that each construct accounted for more than 50% of the variance in its indicators.

Table 3

Summary of Construct Validity and Reliability

Variable	AVE	Cronbach's Alpha	Composite Reliability	Remarks
X1	0,988	0,988	0,996	Reliable
X2	0,992	0,992	0,998	Reliable
X3	1,000	1,000	1,000	Reliable
X4	1,000	1,000	1,000	Reliable
X5	0,993	0,993	0,998	Reliable
X6	1,000	1,000	1,000	Reliable
X7	1,000	1,000	1,000	Reliable
X8	1,000	1,000	1,000	Reliable
Y	0,994	0,994	0,999	Reliable
Z	0,988	0,988	0,996	Reliable

Source: Primary data processed with SmartPLS (2026)

The outer-loading assessment was conducted in two stages. In the first stage, all indicators were assessed simultaneously, and indicator Y2 was found to have an outer loading of 0.018, below the minimum threshold of 0.70. In the second stage, Y2 was removed, and the model was reassessed. The results indicated that all remaining indicators associated with constructs X1–X8, Y, and Z met the specified criteria for convergent validity. The measurement model was therefore subjected to further evaluation of discriminant validity and construct reliability.

A more detailed examination of the measurement model indicated that all retained indicators had outer loadings above 0.70 and that the square root of the AVE for each construct exceeded its correlations with the other constructs, satisfying the Fornell–Larcker criterion for discriminant validity. Nevertheless, the AVE values (0.988–1.000), Cronbach's alpha coefficients, and composite reliability values approaching 1.00 warrant critical interpretation rather than being regarded as evidence of a flawless measurement instrument. Such near-perfect values may indicate highly homogeneous or potentially redundant indicators. They also warrant further investigation of the measurement specification and data quality, particularly given the sample size of 80 respondents relative to the ten latent constructs (Hair et al., 2022). Accordingly, the model is not interpreted as perfectly robust. Its evaluation considers the combined evidence from measurement-model quality, discriminant validity, effect sizes, and the statistical significance of structural relationships, while acknowledging the unusually high measurement statistics as a methodological concern.

Discriminant validity was assessed using cross-loadings, latent-variable correlations, and the Fornell–Larcker criterion. The results indicated that most indicators had their highest correlations with their respective constructs, although some pairs of constructs, particularly among the communication barrier constructs (X1–X8), exhibited relatively high correlations. Cronbach's alpha coefficients ranged from 0.988 to 1.000, while composite reliability values ranged from 0.996 to 1.000 (Table 3), indicating high internal consistency among the retained indicators. However, these coefficients, together with the very high AVE values and several estimates equal to 1.000, require cautious interpretation because they may reflect highly homogeneous or potentially redundant indicators. Therefore, the measurement model was not evaluated solely based on reliability coefficients but also in conjunction with discriminant validity, effect sizes, and the significance of structural relationships. Model fit assessment yielded a standardized root mean square residual (SRMR) of 0.005, a squared Euclidean distance (d_ULS)

of 0.023, a goodness-of-fit (GoF) value of 0.998, and a normed fit index (NFI) of 0.587. These indices should not be interpreted independently as evidence of perfect model fit, particularly because the GoF index is not generally recommended as a stand-alone measure of model fit in PLS-SEM. Accordingly, the model evaluation emphasizes measurement-model quality, coefficients of determination (R^2), effect sizes, and the statistical significance of structural relationships.

Evaluation of the Structural Model (Inner Model)

The coefficient of determination (R^2) for Project Communication Quality (Z) was reported as 1.000, while that for Multi-Project Management Effectiveness (Y) was 0.999. These values indicate that the model accounts for nearly all the variance in the two endogenous constructs. However, R^2 values approaching unity are unusually high and, like the near-perfect measurement statistics, require cautious interpretation. They may reflect indicator redundancy, construct overlap, model specification issues, or other data-related factors rather than exceptionally strong predictive performance. The results of hypothesis testing for the 25 hypothesized relationships, obtained through bootstrapping, are presented in Table 4.

Table 4

Hypothesis Testing Results (Bootstrapping)

Hypothesis	Relationships	Path Coefficients	T-Statistics	P-Value	Verdict
H1	X1 → Z	-0,123	2,002	0,045	Accepted
H2	X2 → Z	-0,046	0,698	0,485	Rejected
H3	X3 → Z	-0,583	2,316	0,021	Accepted
H4	X4 → Z	0,135	0,401	0,688	Rejected
H5	X5 → Z	-0,059	0,805	0,421	Rejected
H6	X6 → Z	1,485	1,659	0,097	Rejected
H7	X7 → Z	0,307	0,825	0,409	Rejected
H8	X8 → Z	-0,117	0,566	0,571	Rejected
H9	X1 → Y	-0,067	1,045	0,296	Rejected
H10	X2 → Y	-0,249	2,136	0,033	Accepted
H11	X3 → Y	-0,508	1,478	0,140	Rejected
H12	X4 → Y	-0,136	0,389	0,697	Rejected
H13	X5 → Y	0,066	0,664	0,507	Rejected
H14	X6 → Y	0,114	0,257	0,805	Rejected
H15	X7 → Y	1,152	1,584	0,113	Rejected
H16	X8 → Y	-0,180	0,660	0,509	Rejected
H17	Z → Y	0,807	3,131	0,002	Accepted
H18	X1 -> Z -> Y	-0,088	2,404	0,016	Accepted
H19	X2 -> Z -> Y	-0,032	0,849	0,396	Rejected
H20	X3 -> Z -> Y	-0,414	1,886	0,059	Rejected
H21	X4 -> Z -> Y	0,096	0,427	0,670	Rejected
H22	X5 -> Z -> Y	-0,042	0,945	0,345	Rejected
H23	X6 -> Z -> Y	1,056	1,676	0,094	Rejected
H24	X7 -> Z -> Y	0,218	0,823	0,411	Rejected
H25	X8 -> Z -> Y	-0,083	0,574	0,566	Rejected

Source: Primary data processed with SmartPLS (2026)

Of the 25 hypotheses tested, five were supported: H1, H3, H10, H17, and H18. Information Delay (X1) had a statistically significant negative association with Project Communication Quality (Z), with a path coefficient of -0.123 ($t = 2.002$; $p = 0.045$). Communication Media Mismatch (X3) also had a statistically significant negative association with Z, with a path coefficient of -0.583 ($t = 2.316$; $p = 0.021$). Information Ambiguity/Inaccuracy (X2) had a statistically significant negative association with Multi-Project Management Effectiveness (Y), with a path coefficient of -0.249 ($t = 2.136$; $p = 0.033$). Project Communication Quality (Z) had a statistically significant positive association with Y, with a path coefficient of 0.807 ($t = 3.131$; $p = 0.002$). In addition, X1 had a statistically significant negative indirect association with Y through Z, with an indirect-effect

coefficient of -0.088 ($t = 2.404$; $p = 0.016$). The remaining 20 hypotheses were not supported because their p -values exceeded 0.05.

Table 5

Effect Size (f-square)

Variable	f^2 against Y	f^2 against Z	Remarks
X1	0,021	0,145	Small effect on Y; small effect approaching moderate on Z
X2	0,178	0,011	Moderate effect on Y; negligible effect on Z
X3	0,030	0,079	Small effects on Y and Z
X4	0,001	0,002	Negligible effects on Y and Z
X5	0,009	0,014	Negligible effects on Y and Z
X6	0,001	0,191	Negligible effect on Y; moderate effect on Z
X7	0,060	0,007	Small effect on Y; negligible effect on Z
X8	0,004	0,004	Negligible effects on Y and Z
Z	0,389	-	Large effect on Y

Source: Primary data processed with SmartPLS (2026)

The effect-size (f^2) results in Table 5 show that the effect of Z on Y had an f^2 value of 0.389, indicating a large effect under conventional guidelines. This result suggests that Project Communication Quality makes a substantial contribution to explaining Multi-Project Management Effectiveness within the estimated model. Regarding Z, X1 had an f^2 value of 0.145, indicating a small-to-moderate effect, while X6 had an f^2 value of 0.191, indicating a moderate effect. However, the direct structural relationship between X6 and Z was not statistically significant in the bootstrapping test. Regarding Y, X2 had an f^2 value of 0.178, indicating a moderate effect.

Results of Importance-Performance Map Analysis (IPMA)

IPMA evaluates constructs or indicators along two dimensions: importance, typically represented by the total effect on a target construct, and performance, represented by the rescaled performance score. Average reference lines may be used to distinguish relative priority areas. Because X1–X8 represent communication barriers, their performance scores should be interpreted in accordance with the indicator coding. If higher scores represent more severe barriers, a higher performance score indicates a more pronounced barrier rather than better performance. The IPMA results for Project Communication Quality (Z) identify X1 (Information Delay) and X3 (Communication Media Mismatch) as key improvement priorities because both were reported to occupy the high-importance quadrant and had statistically significant negative direct associations with Z. Their actual performance scores should be examined alongside these effects to determine the extent to which the corresponding barriers remain pronounced in practice. Other variables that were not statistically significant predictors of Z, such as X6, may still warrant managerial monitoring if their IPMA scores indicate practical importance. Thus, IPMA interpretation should consider importance and performance together rather than relying exclusively on the statistical significance of the PLS-SEM paths.

The IPMA results for Multi-Project Management Effectiveness (Y) identify Project Communication Quality (Z) as the principal construct to strengthen because it had a statistically significant positive association with Y and a large effect size. Among the communication barrier factors, X2 (Information Ambiguity/Inaccuracy) is a priority because it had a statistically significant negative direct association with Y. X1 and X3 are also relevant to improving Y because they had statistically significant associations with Z, which, in turn, was significantly associated with Y. Their potential indirect effects on Y should nevertheless be distinguished: only the indirect effect of X1 through Z was statistically significant, whereas the corresponding indirect effect of X3 was not significant at the 0.05 level. Factors X4, X5, X6, X7, and X8 may be retained as monitoring considerations and supporting elements of improvement strategies because they may be practically relevant to coordination, approval processes, and information follow-up in multi-project implementation. However, their designation as monitoring priorities constitutes a managerial recommendation rather than a statistically established effect on Y, because their direct

paths to Y were not statistically significant in the PLS-SEM analysis.

Based on the IPMA results, the communication improvement strategy was formulated around the following priorities: (1) strengthening Project Communication Quality through a cross-project communication management plan specifying communication responsibilities, official communication channels, reporting formats, documentation systems, and escalation procedures; (2) standardizing information clarity and accuracy through standardized instruction formats, document and revision registers, and information validation before dissemination to the field, thereby addressing X2; (3) accelerating information distribution by establishing information-delivery deadlines, scheduled progress updates, and issue-status dashboards, thereby addressing X1; (4) aligning communication channels with project-specific technical requirements, particularly by using official, documented channels for information affecting time, cost, quality, and design, thereby addressing X3; and (5) implementing supporting measures, including aligning stakeholder perceptions, simplifying procedural workflows, and ensuring consistent communication follow-up through decision logs, action lists, and technical clarification meetings.

Final Expert Validation

Final expert validation was conducted with three experts to confirm the relevance of the research findings to the three research questions. All experts agreed that the first research question had been addressed through the literature review and initial expert validation, which identified eight relevant communication barrier factors. The experts also agreed that the PLS-SEM results explained the direct and indirect relationships among the variables, including the five supported hypotheses (H1, H3, H10, H17, and H18). In addition, the experts considered the IPMA-based communication improvement priorities relevant to the practical context of multi-project implementation.

Discussion

The findings indicate that the first research question was addressed through the literature review and initial expert validation rather than through the ranking of respondents' mean questionnaire scores. These procedures identified eight communication barrier dimensions relevant to parallel construction projects: Information Delay (X1), Information Ambiguity/Inaccuracy (X2), Communication Media Mismatch (X3), Information Overload/Underload (X4), Procedural/Structural Barriers (X5), Differences in Perceptions Between Stakeholders (X6), Inadequate Communication Frequency (X7), and Unclear Communication Plan (X8). These eight factors formed the basis for the PLS-SEM and IPMA models. Accordingly, questionnaire analysis was not used to determine the dominant factors for the first research question.

Regarding the scope of the analysis, this study addresses a gap identified in the literature review: the limited attention given to the effectiveness of communication systems across multiple projects implemented simultaneously within one area under a single supervisory entity. Whereas Suleiman (2022) and Rahimian et al. (2022) examined communication in broader project or industry contexts, and Muhaemin and Suroso (2025) focused on a single multistory building project, the present study positions the Construction Management Consultant as a strategic coordination node responsible for managing information flows across work packages. The findings, particularly the role of Project Communication Quality as a mediating construct, provide a more context-specific account of how communication barriers may affect project management effectiveness across parallel projects.

Of the 25 hypothesized relationships tested, five were statistically significant (H1, H3, H10, H17, and H18). These relationships form the core of the following discussion. The statistically significant negative association between Information Delay (X1) and Project Communication Quality (Z) indicates that greater perceived delays in information delivery are associated with lower project communication quality. This finding is consistent with the explanation that information delays can arise when information passes through multiple organizational levels before reaching the parties who need it, resulting in time lags that interfere with timely decision-making (Aziz et al., 2022). In multi-project settings supervised by a single Construction

Management Consultant, layered organizational structures may increase the risk of such delays. Timely information distribution, scheduled progress updates, and documented follow-up are therefore important managerial considerations.

Communication Media Mismatch (X3) also had a statistically significant negative association with Project Communication Quality (Z), with the largest absolute path coefficient among the direct paths to Z. This finding is consistent with the view that communication channels that do not match the urgency or complexity of technical information may increase the potential for misinterpretation (Yang et al., 2025). In multi-project environments involving substantial volumes of technical documents, design revisions, and work instructions, distributing technical information through informal channels without official supporting documents may reduce communication quality. Consequently, aligning communication channels with the nature and complexity of project information may be particularly important in settings characterized by numerous concurrent work packages and complex documentation requirements.

Information Ambiguity/Inaccuracy (X2) was not statistically significantly associated with Z but had a statistically significant negative direct association with Multi-Project Management Effectiveness (Y). This pattern suggests that the consequences of ambiguous or inaccurate information may be more directly reflected in implementation effectiveness and operational decision-making than in respondents' overall perceptions of communication quality. The finding is consistent with the view that ambiguous work instructions, incomplete technical documentation, and inconsistent revision information can trigger miscommunication and adversely affect work implementation (Aziz et al., 2022; Malik et al., 2021).

The statistically significant positive association between Project Communication Quality (Z) and Multi-Project Management Effectiveness (Y), together with the large effect size ($f^2 = 0.389$), identifies Z as an important construct in the estimated research model. This finding is consistent with the view that high-quality communication, characterized by a shared understanding that minimizes the need for additional interpretation Lubis (2021) and supported by two-way communication when resolving technical problems (Soomro et al., 2024), is an important condition for effective project management. In multi-project contexts, communication quality may support coordination, decision-making, and control of work implementation across concurrent projects. Accordingly, strengthening communication quality may provide a useful managerial leverage point for Construction Management Consultant organizations overseeing numerous projects with limited supervisory resources. However, the unusually high R^2 values and measurement statistics reported in this study should be considered when interpreting the magnitude and robustness of these relationships.

The simultaneous statistical significance of H1, H17, and H18 is consistent with a mediation mechanism in which Information Delay (X1) affects Multi-Project Management Effectiveness (Y) indirectly through Project Communication Quality (Z). Theoretically, delays in information distribution may undermine the timeliness, clarity, and shared understanding associated with communication quality. Reduced communication quality may, in turn, contribute to slower and less synchronized decision-making across parallel projects, potentially reducing management effectiveness. Because the direct effect of X1 on Y was not statistically significant (H9), whereas its indirect effect through Z was statistically significant (coefficient = -0.088; $t = 2.404$; $p = 0.016$), the results are consistent with indirect-only mediation, commonly referred to as full mediation in traditional terminology. This classification should be understood in relation to the estimated model and the statistical power of the study rather than as proof that no direct effect exists. Practically, the findings suggest that reducing information delays may improve multi-project effectiveness partly by strengthening project communication quality. Therefore, communication quality should be considered alongside information-delivery timeliness when designing improvement measures.

The remaining 20 hypotheses, including those involving Information Overload/Underload (X4), Procedural/Structural Barriers (X5), Differences in Perceptions Between Stakeholders (X6), Inadequate Communication Frequency (X7), and Unclear Communication Plan (X8), were not statistically significant in the estimated model. The absence of statistically significant relationships does not necessarily mean that these dimensions lack managerial relevance. The f^2 value of X6 for Z (0.191), which falls within the moderate-effect range under conventional

guidelines, suggests that differences in stakeholder perceptions may have a potentially meaningful contribution to Project Communication Quality, even though the corresponding structural path was not statistically significant in the bootstrapping test. Similarly, simplifying approval workflows and clarifying decision-making authority in relation to X5, managing information priorities in relation to X4, maintaining consistent communication frequencies in relation to X7, and preparing formal communication plans in relation to X8 may be useful supporting measures for communication management in multi-project implementation. These recommendations are consistent with the managerial interpretation of the IPMA results, but they should not be presented as statistically confirmed effects.

The findings extend the literature on interproject integration in construction organizations managing multiple projects concurrently by Bosfield et al. (2026) highlighting the potential importance of communication quality as a mediating construct rather than attributing integration success solely to the adoption of technologies such as building information modeling (BIM) or common data environments (CDEs). As emphasized in previous research, communication integration challenges involve not only technological considerations but also procedural consistency, communication culture, and human resource competence (Likita et al., 2025). The findings are also consistent with Saputro (2024), who employed a similar PLS-SEM approach and found that ineffective communication can exhibit selective causal pathways, such that not all barrier dimensions have statistically significant effects. This supports the practical rationale for prioritizing interventions on dimensions that demonstrate stronger empirical relationships rather than distributing remedial resources equally across all communication barriers. The importance of communication quality is also consistent with Mareno et al. (2022) and Jaya et al. (2023), whose studies reported relationships between communication quality and project schedule performance in different contexts.

Practically, these findings suggest that Construction Management Consultant X should prioritize a cross-project communication management plan, with particular attention to accelerating information distribution and ensuring that communication channels are appropriate for technical information. These priorities correspond to the statistically significant negative associations of X1 and X3 with Project Communication Quality. For owners and PPKs, standardizing information formats and clarifying document revision status may help address information ambiguity and inaccuracy, which showed a statistically significant negative association with Multi-Project Management Effectiveness. These implications may also be relevant to organizations managing development areas containing multiple concurrent work packages, particularly where layered supervisory structures and multiple stakeholders create communication challenges similar to those documented in previous studies (Ibdayanti, 2023; Peli et al., 2022).

This study has several limitations that should be considered when interpreting the findings and designing future research. First, the sample comprised 80 respondents, while the model included ten latent constructs. The unusually high outer loadings, AVE values, reliability coefficients, and R^2 values approaching their upper limits warrant further investigation. Future research should use larger samples and examine the measurement specification, potential indicator redundancy, construct overlap, and collinearity to establish whether the results remain stable under different conditions. Second, the study focused on a single Construction Management Consultant operating within one national development area. Generalizing the findings to multi-project contexts with different institutional arrangements, supervisory structures, and project characteristics should therefore be done cautiously. Third, the model did not include other potentially relevant variables, such as organizational culture, project leadership style, the maturity of project information systems, and the level of digital technology adoption. Future studies could incorporate these variables to develop a more comprehensive understanding of the factors associated with multi-project management effectiveness.

CONCLUSION

Addressing the three research objectives, this study draws the following conclusions. First, eight communication barrier factors were identified as relevant to multi-project implementation under a single Construction Management Consultant through a literature review and initial expert

validation, rather than through the ranking of questionnaire mean scores. These factors are Information Delay (X1), Information Ambiguity/Inaccuracy (X2), Communication Media Mismatch (X3), Information Overload/Underload (X4), Procedural/Structural Barriers (X5), Differences in Perceptions Between Stakeholders (X6), Inadequate Communication Frequency (X7), and Unclear Communication Plan (X8). Second, five of the 25 hypothesized relationships were statistically significant (H1, H3, H10, H17, and H18). Information Delay (X1) and Communication Media Mismatch (X3) had statistically significant negative associations with Project Communication Quality (Z); Information Ambiguity/Inaccuracy (X2) had a statistically significant negative association with Multi-Project Management Effectiveness (Y); Project Communication Quality (Z) had a statistically significant positive association with Y; and X1 had a statistically significant indirect association with Y through Z. Third, the IPMA-based recommendations prioritize strengthening Project Communication Quality through a cross-project communication management plan, followed by standardizing information clarity and accuracy, accelerating information distribution, and aligning communication channels with technical requirements. Overall, the findings suggest that communication quality is an important pathway through which communication barriers may affect multi-project management effectiveness. The proposed priorities were also considered relevant to the study context through final expert validation. Nevertheless, the unusually high measurement statistics and R^2 values warrant further examination before the findings can be regarded as robust or generalized to other settings.

Future research should test the model across a larger number of Construction Management Consultants or other relevant organizations and across projects with more diverse characteristics. This would allow the unusually high validity, reliability, and R^2 values observed in the present study to be reassessed using a larger and more heterogeneous sample. Subsequent studies should also consider incorporating the variables identified as limitations of this research, including organizational culture, project leadership style, the maturity of project information systems, and the level of digital technology adoption, to develop a more comprehensive understanding of the determinants of multi-project management effectiveness.

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AUTHOR CONTRIBUTION STATEMENT

Caroline Thiovila D A, Yunita Dian Suwandari, and Mawardi Amin contributed to the development of this study. The authors jointly contributed to the study design, the interpretation of the findings, and the preparation and revision of the manuscript. All authors reviewed and approved the final version of the manuscript.

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