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The Influence of Field Supervision on Construction Work Quality: a PLS-SEM Model of the Batupanga Community Health Center Project

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Abstract

Construction quality depends on effective field supervision, compliance with technical specifications, and timely corrective actions. However, empirical evidence regarding these relationships in healthcare facility construction projects remains limited. This study examined the relationship between field supervision and construction work quality in the Batupanga Community Health Center construction project in Luyo District, Polewali Mandar Regency, Indonesia. A quantitative research approach was employed, involving 15 respondents purposively selected based on their direct involvement in project implementation. Data were collected through questionnaires comprising five indicators for each construct, supplemented by field observations and project documentation. The data were analyzed using partial least squares structural equation modeling (PLS-SEM). Measurement model evaluation indicated acceptable convergent validity and internal consistency reliability, with average variance extracted (AVE) values of 0.582 and 0.512 and composite reliability values of 0.873 and 0.838 for the respective constructs. The structural model revealed a positive and statistically significant association between field supervision and perceived construction work quality ($\beta = 0.512$; $t = 2.418$; $p = 0.017$). Field supervision explained 26.2% of the variance in perceived construction work quality ($R^2 = 0.262$), with an effect size of 0.355 (f^2). Inspector accuracy and inspection intensity emerged as prominent indicators of field supervision. These findings underscored the importance of systematic inspections, effective coordination, and documented corrective actions in supporting construction quality. However, the limited explanatory power of the model suggested that additional factors also contributed to variations in perceived work quality. The study concluded that field supervision was positively associated with construction work quality, although the small, purposively selected sample and single-project setting limited the generalizability of the findings. Future research should include larger samples across multiple construction projects and examine additional predictors, including workforce competence, material quality, design clarity, and environmental conditions.

INTRODUCTION

Construction quality is determined not only by design specifications and material selection but also by the interaction of project planning, site execution, inspection, communication, corrective actions, and project team competence. Field supervision therefore serves as a critical operational mechanism for translating contractual requirements and technical specifications into effective control of daily construction activities (Manoharan et al., 2024; Rahayu et al., 2025; Sami Ur Rehman et al., 2023; Seboka & Gidebo, 2026). Recent

construction management studies have emphasized the importance of quality management processes, stakeholder coordination, systematic supervision, documentation, and timely corrective actions in minimizing construction defects and improving project outcomes (Egwunatum et al., 2022; Hoła et al., 2023; Lambers et al., 2024; Willar et al., 2022).

Construction quality failures can generate substantial costs through rework, additional inspections, operational disruptions, contractual claims, and project delays. Garg and Misra (2022) demonstrated that prevention and appraisal activities were closely associated with quality-related costs in building construction projects. Similarly, Khadim et al. (2023) highlighted that a considerable proportion of quality-related costs remained hidden beyond immediately observable defects. Rework has also been identified as a persistent challenge in construction projects because it increases labor and material consumption while adversely affecting project costs, quality, and schedule performance (Hassan et al., 2023; Yap et al., 2022).

Within this context, field supervision functions as an essential component of construction quality control. Effective supervision extends beyond routine observation to include verifying compliance with construction drawings and technical specifications, coordinating project personnel, identifying deviations, and implementing corrective actions (Manoharan et al., 2024; Sakuntara & Rarasati, 2022). Willar et al. (2022) found that quality management practices in Indonesian road construction projects were strongly associated with project team competence, commitment, cooperation, supervision of compliance with established standards, and systematic performance reporting. These findings supported the examination of field supervision as a measurable construct associated with construction work quality rather than merely an administrative function (Dwiretnani et al., 2024; Gunawan & Anita, 2025; Helmi et al., 2025; Perdana et al., 2025; Taqiudin et al., 2023).

This study focused on the Batupanga Community Health Center construction project in Luyo District, Polewali Mandar Regency, Indonesia. Preliminary findings indicated relatively high respondent ratings of both field supervision and construction work quality. However, the results also suggested that construction quality was associated with additional factors beyond field supervision. This observation raised an important research question concerning the extent to which field supervision could statistically explain variations in perceived construction work quality within the project.

Partial least squares structural equation modeling (PLS-SEM) was employed to examine the relationship between field supervision and construction work quality as latent constructs measured through multiple indicators. This approach was selected to support exploratory modeling within the study's limited sample, although the small sample size constrained statistical precision and the robustness of the estimates (Hadi et al., 2026). Zeng et al. (2021) emphasized that the application of PLS-SEM in construction management research required explicit model specification and systematic evaluation of both measurement and structural models. Accordingly, this study evaluated indicator loadings, average variance extracted (AVE), composite reliability (CR), path coefficients, t-statistics, p-values, the coefficient of determination (R^2), and effect size (f^2) to provide a comprehensive assessment of the estimated relationships.

This study contributed to construction management research in three respects. First, it provided project-specific empirical evidence regarding the association between field supervision and perceived construction work quality. Second, it examined the relative contributions of observed indicators to their respective latent constructs, offering insights into the measurement of supervision and quality within the project. Third, it identified the 73.8% of unexplained variance in construction work quality as an indication that additional determinants warranted investigation, rather than as evidence that field supervision lacked importance. This distinction was particularly relevant given the multidimensional nature of construction quality and the methodological limitations associated with small-sample, single-project studies.

METHOD

Research design and setting

This study employed a quantitative survey approach to examine the relationship between field supervision and construction work quality in the Batupanga Community Health Center construction project in Luyo District, Polewali Mandar Regency, Indonesia. Both variables were modeled as latent constructs, and their relationship was analyzed using partial least squares structural equation modeling (PLS-SEM). Data were collected through questionnaires, supplemented by field observations and project documentation.

Population, sample, and respondents

Fifteen respondents were selected purposively because they were directly involved in project execution. The respondent profile indicates substantial technical exposure: 13 respondents (86.67%) had a bachelor's degree in civil engineering, while the remaining respondents had vocational or senior-secondary backgrounds. Regarding work experience, eight respondents (53.33%) had 2–5 years of experience, six (40.00%) had 6–10 years, and one (6.67%) had more than 10 years. The sample should therefore be interpreted as a project-specific expert/participant sample rather than as a statistically representative sample of the Indonesian construction industry.

Measures and questionnaire

The questionnaire used a five-point Likert scale, with response values representing increasing agreement or perceived performance. Field supervision was measured using five indicators (X1–X5), and work quality was measured using five indicators (Y1–Y5). The indicators were retained in the reported PLS-SEM model and evaluated through outer loadings, AVE, and composite reliability.

PLS-SEM procedure

The analysis followed two linked stages. First, the measurement model was assessed through indicator loadings, AVE, and composite reliability. Second, the structural model was assessed through the path coefficient, t-statistic, p-value, R^2, and f^2. The use of PLS-SEM is consistent with methodological discussions that stress careful separation of measurement-model assessment from structural-model evaluation (Zeng et al., 2021).

Because the sample contains only 15 observations, the numerical results should be treated as project-level evidence and not as a basis for broad population inference. The

significance result is reported exactly as obtained in the source analysis; future studies should replicate the model using a larger and more heterogeneous sample.

Hypothesis

The conceptual relationship is straightforward: stronger and more systematic field supervision should improve the probability that construction activities conform to drawings, specifications, workmanship requirements, and quality expectations. Accordingly, the study tests the following hypothesis:

H1: Field supervision has a positive and significant effect on construction work quality.

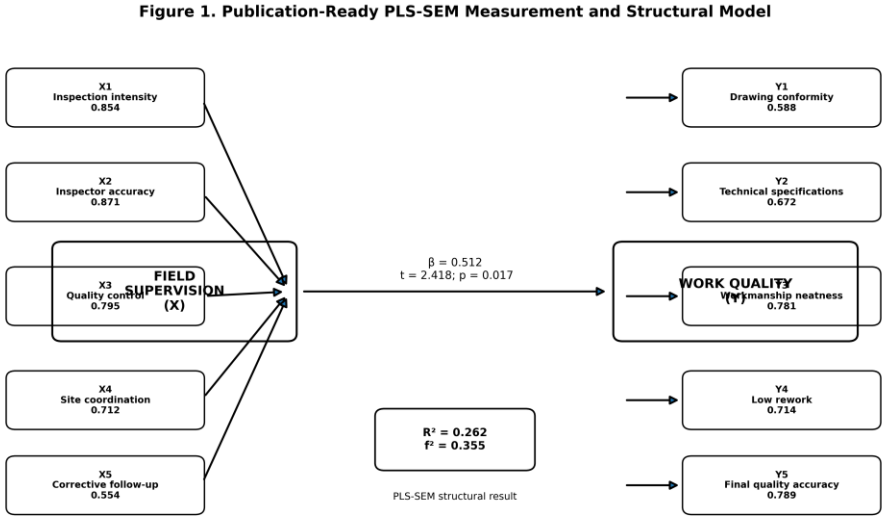

Figure 1. Publication-ready PLS-SEM measurement and structural model. Values shown are based on the reported study results.

RESULTS AND DISCUSSION

Descriptive profile

The descriptive results indicate a generally favourable perception of both constructs. Field supervision obtained an overall mean of 4.56, while work quality obtained an overall mean of 4.61 on the five-point scale. Within field supervision, corrective follow-up (X5) recorded the highest mean at 4.67. Within work quality, low rework (Y4) recorded the highest mean at 4.80. These values suggest that respondents perceived supervision and quality performance as very high in the project.

The high descriptive scores should not be confused with a causal conclusion. A high mean describes the perceived level of a construct, whereas PLS-SEM estimates the relationship between constructs. The coexistence of high means and a moderate R^2 is therefore plausible: a project may perform well overall while still having multiple determinants of quality that are not included in a one-predictor model.

Measurement model

Table 1. PLS-SEM measurement model results

Construct	Indicator	Loading	AVE	Composite reliability
Field supervision	X1	0.854	0.582	0.873
Field supervision	X2	0.871		

Construct	Indicator	Loading	AVE	Composite reliability
Field supervision	X3	0.795		
Field supervision	X4	0.712		
Field supervision	X5	0.554		
Work quality	Y1	0.588	0.512	0.838
Work quality	Y2	0.672		
Work quality	Y3	0.781		
Work quality	Y4	0.714		
Work quality	Y5	0.789		

The field-supervision construct achieved loadings ranging from 0.554 to 0.871, AVE of 0.582, and composite reliability of 0.873. The work-quality construct achieved loadings ranging from 0.588 to 0.789, AVE of 0.512, and composite reliability of 0.838. On the criteria used in the source analysis, both constructs satisfy convergent validity and reliability requirements. The relatively lower loading of X5 (0.554) and Y1 (0.588) should nevertheless be recognised as an area for future instrument refinement rather than automatically interpreted as evidence that the indicators are unimportant.

The loading pattern also provides substantive information. X2 (inspector accuracy) is the strongest field-supervision indicator, followed by X1 (inspection intensity) and X3 (quality control). For work quality, Y3 (workmanship neatness) and Y5 (final quality accuracy) are among the strongest indicators. These results suggest that respondents associate effective supervision particularly with accurate inspection and that perceived quality is strongly connected with visible workmanship and final accuracy.

Structural model and hypothesis test

Table 2. Structural model results

Relationship	β	t-statistic	p-value	R^2	f^2
Field supervision → Work quality	0.512	2.418	0.017	0.262	0.355

The path coefficient from field supervision to work quality is $\beta = 0.512$, with $t = 2.418$ and $p = 0.017$. The reported p-value is below 0.05; therefore, H1 is supported in the analysed sample. The positive coefficient indicates that higher levels of field supervision are associated with higher levels of perceived work quality.

The R^2 value of 0.262 indicates that field supervision accounts for 26.2% of the variance in work quality in the model. The remaining 73.8% is not an analytical failure; rather, it indicates that construction quality is affected by additional factors outside the model. The source study identifies workforce competence, material quality, and environmental/weather conditions as plausible contributors. The f^2 value of 0.355 indicates a substantial effect according to the interpretation used in the source analysis.

Field supervision and work quality

The positive path coefficient provides empirical support for the proposition that field supervision is an important quality-control mechanism in construction. The result is consistent with the broader construction quality literature, which emphasises supervision, project-team competence, documentation, and control activities. Willar et al. (2022) found that quality-management implementation in Indonesian road projects depends strongly on project-team interaction, competence, commitment, cooperation, supervision, and performance reporting.

Although their context differs from the present building project, the underlying managerial logic is comparable.

The finding also aligns with the quality-cost perspective. Garg and Misra (2022) show that prevention and appraisal are important components of construction quality cost. In practical terms, field supervision performs part of this prevention and appraisal function: supervisors identify deviations before they become embedded in later work, while inspection verifies compliance. When corrective action occurs early, the project can avoid the greater disruption associated with completed defective work.

The result is also compatible with research on rework. Yap et al. (2022) emphasise managerial measures that reduce rework, while Hassan et al. (2023) identify multiple causes of rework across design and construction stages. In the present study, Y4—low rework—has the highest descriptive mean. This does not prove that supervision alone caused the low rework level, but it is consistent with the proposition that timely inspection and corrective follow-up can reduce the probability that defects progress into rework.

Interpreting the indicator pattern

Inspector accuracy (X2) has the highest loading among the supervision indicators at 0.871. This suggests that the ability of supervisory personnel to accurately assess work conditions is particularly central to the latent supervision construct. Inspection intensity (X1) also loads strongly at 0.854, indicating that the frequency and presence of inspection are closely associated with perceived supervision quality. Quality control (X3) has a loading of 0.795, reinforcing the role of systematic quality checks.

Site coordination (X4) has a loading of 0.712. This is important because supervision does not occur in isolation. Construction quality depends on coordination between supervisors, contractors, workers, suppliers, and other project actors. The literature on construction quality management similarly stresses stakeholder interaction and the clarity of quality responsibilities (Egwunatum et al., 2022; Willar et al., 2022).

Corrective follow-up (X5) has the lowest loading at 0.554, but its descriptive mean is the highest among the supervision indicators (4.67). This apparent difference is analytically meaningful. A high mean means respondents generally perceive corrective follow-up to be well implemented, whereas a lower loading means that variation in this indicator is less strongly aligned with the overall latent construct than the other indicators. It should therefore not be concluded that corrective follow-up is unimportant.

Why 73.8% remains unexplained

The R^2 value of 0.262 is a central finding because it prevents an overly deterministic interpretation of supervision. Construction work quality is a multi-factor outcome. Labour competence can affect workmanship; material quality can affect compliance and durability; weather can alter workability and sequencing; equipment availability can influence execution; design clarity can affect implementation; and communication can influence whether instructions are understood and acted upon.

This interpretation is supported by the wider literature. Faraji et al. (2022) demonstrate that construction quality management can require integrated information and technology systems. Lekan et al. (2022) show the potential of Construction 4.0, IoT, and lean tools in quality management. Recent work on automated quality supervision also indicates that digital

monitoring may strengthen the ability to detect critical activities and deviations (Guo et al., 2025). These findings suggest that a future expanded model could combine human supervision with information quality, technology adoption, workforce competence, and material-control variables.

Methodological contribution and caution

The study also illustrates why PLS-SEM reporting should go beyond a single significant path. Zeng et al. (2021) reviewed the use of PLS-SEM in construction management and highlighted the need to distinguish model development from model evaluation and to avoid misuse of the technique. The present article therefore reports measurement and structural results separately and explicitly describes the limitations of the 15-person sample.

The evidence should be interpreted as a project-level empirical case. The significant p-value does not establish universal causality across construction projects. The model contains one exogenous latent variable and one endogenous latent variable, so it is intentionally parsimonious. A larger multi-project study would provide a stronger basis for testing whether the observed coefficient remains stable across project size, procurement method, location, contractor characteristics, and supervisory arrangements.

Practical Implications

First, project managers should prioritise supervision at critical construction points rather than relying on uniform inspection effort. Activities with high consequences for downstream quality—such as structural concrete placement, reinforcement installation, embedded services, waterproofing, and medical-utility installations—benefit from direct verification before work proceeds to the next stage.

Second, inspection should be linked to documented corrective action. A supervision system is stronger when a deviation is recorded, assigned to a responsible party, corrected, and re-inspected. This creates a closed-loop quality-control process rather than a purely observational activity.

Third, site coordination should be integrated into quality management. Supervisors should communicate inspection findings promptly to contractors and workers, particularly where work sequences or interfaces between disciplines can create nonconformities.

Fourth, the unexplained variance suggests that organisations should not treat supervision as a substitute for workforce competence, material control, design quality, or environmental planning. A balanced quality system should address these factors simultaneously.

Finally, digital tools can be considered as supporting mechanisms. BIM, UAV-based inspection, IoT-enabled monitoring, and video-based activity recognition are emerging approaches that can strengthen evidence collection and quality assurance (Faraji et al., 2022; Guo et al., 2025; Lekan et al., 2022). Their value should be evaluated according to the project's scale, cost, data requirements, and supervisory capacity.

CONCLUSION

This study examined the relationship between field supervision and construction work quality in the Batupanga Community Health Center construction project using partial least squares structural equation modeling (PLS-SEM). The results revealed a positive and

statistically significant association between field supervision and construction work quality ($\beta = 0.512$; $t = 2.418$; $p = 0.017$). The structural model explained 26.2% of the variance in perceived construction work quality ($R^2 = 0.262$), with an effect size of $f^2 = 0.355$.

The measurement model demonstrated acceptable convergent validity and composite reliability for both constructs based on the evaluation criteria applied in the study. Inspector accuracy and inspection intensity exhibited the strongest indicator loadings for field supervision, whereas workmanship neatness and final work quality accuracy were among the strongest indicators of construction work quality. Corrective follow-up recorded the highest descriptive mean among the supervision indicators, although its outer loading was comparatively lower, indicating a distinction between respondents' average ratings and the indicator's relationship with the latent construct.

The findings highlighted the practical importance of systematic field supervision in supporting construction work quality while indicating that construction quality was influenced by multiple factors. The remaining 73.8% of unexplained variance suggested the need to investigate additional determinants, including workforce competence, material quality, design and documentation quality, environmental conditions, project communication, digital quality management tools, and other project-level controls. Future research should incorporate these variables and employ larger samples across multiple construction projects to improve statistical power, strengthen the robustness of the findings, and enhance their generalizability.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this study. This research is free from any commercial or financial relationships that could potentially create a conflict of interest.

AUTHOR CONTRIBUTION

All authors contributed equally to this research, including the conception of ideas, data collection and analysis, and the preparation of the manuscript.

GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

In the process of preparing this article, the authors used artificial intelligence (AI) assistance limited solely to grammar improvement and language checking, without influencing the substance, analysis, or findings of the research.

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