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Identification and Descriptive Assessment of Construction Delay Risks in A Research Building Project in Central Sulawesi, Indonesia

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ABSTRACT: A research building construction project in Central Sulawesi, Indonesia, recorded actual cumulative progress of 59.005%, compared with planned progress of 68.617%, at week 29 of a 43-week contract, indicating a delay of 9.612 percentage points. This discrepancy highlighted the need for project-specific identification of potential construction delay risks. This study aimed to identify and assess potential factors contributing to construction delays using a descriptive quantitative approach based on a structured questionnaire survey. A total sampling method was employed, involving all 27 project personnel within the defined study population. Twenty-eight potential delay indicators were identified from the existing literature and adapted to the project context. Item validity was assessed using Pearson item–total correlations, which ranged from 0.383 to 0.780, exceeding the adopted critical value of 0.381. The questionnaire demonstrated high internal consistency, with a Cronbach's alpha coefficient of 0.907. Indicators were screened using a predefined exclusion criterion, whereby indicators receiving negative responses (strongly disagree or disagree) from more than 50% of respondents were excluded. Consequently, eight indicators were excluded, while 20 were retained, comprising six technical, five managerial, five resource-related, and four external indicators. Material quantity discrepancies and delayed material delivery received the highest levels of agreement, at 92.59% and 88.89%, respectively. The findings provide a project-specific framework for identifying potential construction delay risks and supporting subsequent risk prioritization and mitigation strategies. However, the retention of indicators reflects the absence of majority disagreement rather than empirical confirmation of their occurrence or causal effects. As the study was limited to respondent perceptions within a single construction project, the generalizability of the findings remains limited.

KEYWORDS: Construction project delays; risk identification; risk management; validity and reliability; questionnaire

1. Introduction

Construction projects involve highly interdependent activities, multiple stakeholders, and dynamic resource requirements throughout their implementation. Problems associated with

design, planning, coordination, material procurement, and external environmental conditions can disrupt construction activities and adversely affect project progress. Construction delays remain a significant challenge because they can increase project costs, reduce resource efficiency, and compromise contractual performance. A literature review of Indonesian infrastructure projects identified technical, managerial, and external factors as recurring contributors to construction delays [1]. These factors should be examined comprehensively, as disruptions in one construction activity may influence the readiness, sequencing, and performance of subsequent activities.

Previous studies in Indonesia have identified various factors associated with construction delays across different project types and geographical locations. Research conducted in Central Aceh evaluated 80 potential delay factors and identified equipment failures, inadequate planning and management, specification-related problems, and limited site accessibility as influential risks [2]. Similarly, an investigation involving seven construction projects identified design modifications, delayed material deliveries, and ineffective project management as important delay-related issues [3]. A study in Balikpapan further highlighted discrepancies in design documents, owner-initiated changes, inadequate supervision, material shortages, inappropriate construction methods, and delays in obtaining government permits [4]. Collectively, these findings demonstrate the multidimensional nature of construction delays and provide an empirical foundation for developing comprehensive risk identification frameworks.

Additional studies focusing on building construction projects have emphasized the influence of implementation errors, ineffective coordination, and managerial weaknesses on project performance [5]. Other investigations have identified resource procurement constraints, geographical conditions, adverse weather, and frequent design modifications as potential sources of construction delays [6]. Workforce availability and competency have also been recognized as relevant factors in building construction projects in Sukabumi [7]. Although these studies provide valuable insights, their findings are largely dependent on specific project characteristics and geographical contexts. Differences in organizational structures, construction sequences, procurement systems, workforce capabilities, and environmental conditions may influence the relevance and perceived importance of individual delay factors. Consequently, risk indicators identified in previous studies cannot necessarily be generalized to other construction projects without further contextual assessment.

The present study focuses on a research building construction project in Central Sulawesi, Indonesia, where a substantial discrepancy between planned and actual construction progress was observed. By week 29 of the 43-week contractual period, actual cumulative progress had reached only 59.005%, compared with the planned progress of 68.617%, representing a negative deviation of 9.612 percentage points. This discrepancy indicates that the project was behind its planned schedule and highlights the importance of systematically identifying potential risks that may affect construction progress. However, the observed progress deviation does not independently establish the underlying causes of the delay or confirm whether the project will exceed its contractual completion period. Therefore, a structured assessment of potential delay risks based on the perceptions of personnel directly involved in project implementation is necessary to provide a contextual understanding of the challenges encountered.

Despite the extensive literature on construction delay factors, a methodological and contextual research gap remains in the systematic adaptation and screening of literature-derived risk indicators for individual construction projects. Previous studies have identified numerous potential delay factors, but their relevance to a particular project requires further assessment using clearly defined and reproducible criteria. In particular, statistical item validity and contextual relevance represent different dimensions of indicator evaluation. An indicator may demonstrate an acceptable correlation with the overall questionnaire score while receiving substantial disagreement from project personnel regarding its relevance to the specific project. Conversely, an indicator may be retained through a majority-based screening procedure even when positive agreement is limited, particularly when a considerable proportion of respondents select neutral responses. Distinguishing these assessment dimensions is important to avoid interpreting statistical validity as direct evidence of risk occurrence or causation.

The novelty of this study lies in the integration of statistical questionnaire assessment with a predefined, perception-based screening criterion to develop a project-specific set of construction delay-risk indicators. Rather than assuming that all factors identified in previous studies are equally applicable, the proposed approach systematically evaluates literature-derived indicators through Pearson item–total correlation analysis, internal consistency assessment using Cronbach's alpha, and contextual screening based on respondent disagreement. This approach provides a transparent basis for distinguishing statistically acceptable questionnaire items from indicators retained as potentially relevant to the project. Accordingly, this study aims to identify and screen potential construction delay-risk indicators for a research building construction project in Central Sulawesi, Indonesia, through statistical questionnaire assessment and predefined respondent-based screening criteria. The findings are expected to provide a practical foundation for subsequent risk prioritization, mitigation planning, and improved construction project management.

2. Materials and Methods

2.1. Study design and project context.

A descriptive quantitative case-study approach was employed to examine questionnaire responses concerning potential construction delay risks. The study focused on a research building construction project in Central Sulawesi, Indonesia. The project name, owner, contractor, and exact location are not disclosed to maintain confidentiality. The contractual construction period was 43 weeks. Project progress records were examined to evaluate schedule performance. At the week-29 monitoring point, the difference between actual and planned cumulative progress was calculated as 59.005% − 68.617% = −9.612 percentage points. Architectural, electrical, and mechanical, electrical, and plumbing (MEP) works were reported to be ongoing at this stage. The observed deviation represents a shortfall in cumulative construction progress rather than a confirmed extension of the contractual completion date. A separate questionnaire survey was conducted to assess project personnel's perceptions of potential construction delay risks.

2.2. Study Population, Total Sampling, and Respondent Characteristics.

The study population comprised 27 personnel directly involved in project management, technical coordination, material procurement, and construction activities. A total sampling

approach was adopted, whereby all members of the defined study population were included rather than selecting a smaller sample. This approach was considered appropriate because the population was relatively small and manageable, allowing the study to capture diverse project-level perspectives. However, complete coverage of the defined population does not imply that the findings can be generalized to other construction projects [8]. Furthermore, the sampling frame did not necessarily include every individual employed at the construction site or represent construction workers throughout the region.

Respondents represented various professional and operational roles, including construction management personnel, the site manager, estimators, drafters, a supervisor, surveyors and assistant surveyors, procurement and logistics personnel, a safety and health officer, and assistant foremen responsible for steelwork, reinforcement, formwork, and finishing activities. The distribution of respondents according to their respective roles is presented in Table 1. Construction management personnel and the site manager provided perspectives on project planning and decision-making, while drafters and surveyors contributed technical insights regarding design documentation and site conditions. Procurement and logistics personnel were familiar with material requirements and delivery processes, whereas supervisors and assistant foremen provided perspectives on construction implementation and operational challenges.

The final dataset comprised 27 completed questionnaires, with the response frequencies for each indicator totaling 27. Although the inclusion of multiple professional roles broadened the range of perspectives represented, it did not establish that every respondent had directly observed every potential risk. Therefore, the findings were interpreted as the perceptions of personnel involved in the selected project rather than as representative evidence of construction delay risks across Indonesia.

2.3. Questionnaire Development and Classification of Risk Indicators.

The initial questionnaire was developed through a review of construction delay literature, a preliminary assessment of project conditions, and contextual adaptation of previously identified risk factors. A total of 28 candidate indicators were formulated to represent potential risks associated with technical activities, managerial processes, resource availability, and external conditions. The indicators were designed to reflect the characteristics of the selected construction project rather than to establish an exhaustive or universally applicable construction delay-risk inventory. Their wording and classification were adapted to the project context, and previously reported factors were not assumed to have occurred in the investigated project.

The technical risk category consisted of eight indicators (A1–A8), covering design changes, repeated drawing revisions, discrepancies between drawings and site conditions, inappropriate construction methods, inadequate coordination among structural, architectural, and MEP drawings, incomplete shop drawings, delays in critical activities affecting subsequent work, and delayed drawing approvals. These indicators reflected technical, design-related, and implementation issues identified in previous studies [1,3–6]. The managerial risk category also comprised eight indicators (B1–B8), including unrealistic project schedules, inadequate daily and weekly planning and control, insufficient supervision, ineffective interorganizational coordination, poor internal contractor coordination, delayed decision-making, inconsistent progress monitoring, and inadequate site management. These indicators were developed based on planning, coordination, and management issues discussed in the literature [1,3–5].

The resource-related category comprised seven indicators (C1–C7), including delayed material deliveries, discrepancies in material quantities, insufficient workforce availability, low labor productivity, inadequate foreman guidance, mismatches between worker competencies and assigned tasks, and equipment breakdowns. These indicators addressed the availability, adequacy, and performance of construction materials, personnel, and equipment [2,3,5,7]. The external risk category consisted of five indicators (D1–D5), covering adverse weather conditions, difficult site accessibility, permitting and bureaucratic obstacles, disturbances from surrounding activities, and unforeseen events or force majeure. These indicators reflected environmental, administrative, and accessibility-related challenges reported in previous investigations [1,2,4,6]. The cited literature provided thematic support for indicator development; however, the questionnaire statements were adapted to the project context rather than reproduced verbatim.

Figure 1 presents the conceptual framework used to organize the 28 candidate indicators into four risk categories: technical, managerial, resource-related, and external risks. These categories were considered potential sources of construction schedule disruption and provided the basis for questionnaire development and subsequent indicator screening. The framework was intended as a conceptual classification rather than an empirically validated causal model. Certain indicators may overlap conceptually across categories. For example, foreman guidance involves managerial responsibilities but was classified under resource-related risks because of its association with workforce performance. Similarly, delays in critical activities may represent the propagation of existing disruptions rather than independent initiating factors. Accordingly, the relationships illustrated in Figure 1 should not be interpreted as statistically estimated causal effects.

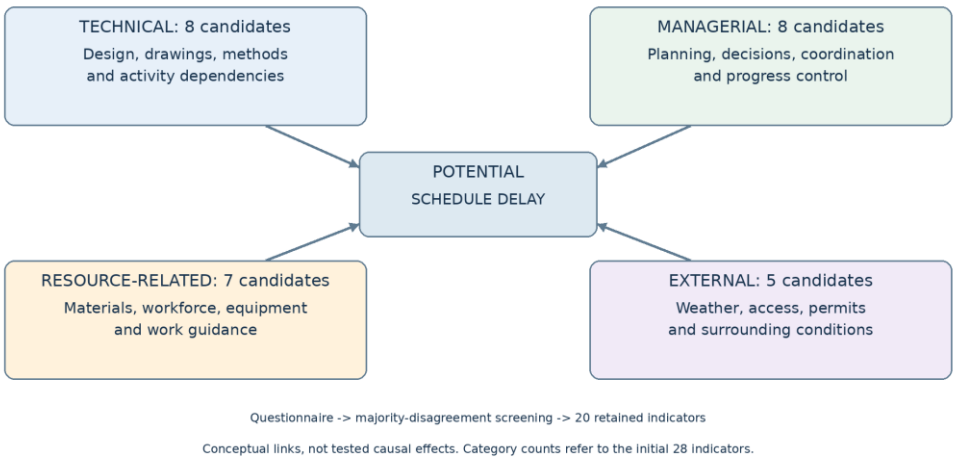


Figure 1. Conceptual Framework of the Four Candidate Risk Categories and Potential Construction Delay.

Each questionnaire item was evaluated using a five-point Likert response scale: strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). Respondents were asked to assess their level of agreement with each potential delay-risk statement in relation to the implementation of the selected project. The resulting scores represented respondents' perceptions rather than direct measurements of risk occurrence, frequency, probability, or causal contribution to construction delays. No separate pilot survey was conducted. Data were collected using Google Forms in August 2026, and the responses were subsequently compiled for instrument assessment and indicator screening.

2.4. Instrument Validity Assessment and Internal Consistency.

Questionnaire data were analyzed using IBM SPSS Statistics. Pearson product–moment correlation analysis was performed to assess the relationship between each indicator score and the total score across all 28 questionnaire items. This item–total correlation approach was adopted as the operational criterion for preliminary item validity assessment, following procedures described in the instrument-testing literature [9]. With 27 respondents, the degrees of freedom were calculated as $n - 2 = 25$. At a two-tailed significance level of 0.05, the adopted critical Pearson correlation coefficient was 0.381. An indicator was considered to satisfy the operational validity criterion when its correlation coefficient exceeded this threshold.

The total questionnaire score included all 28 items, meaning that the calculated coefficients represented uncorrected item–total correlations rather than corrected item–total correlations. This distinction is important because including an individual item in the total score introduces part–whole overlap, potentially increasing the observed correlation. Therefore, satisfying the adopted criterion was interpreted as preliminary evidence of an association between an indicator and the overall questionnaire score. It was not considered sufficient evidence of comprehensive content validity, construct validity, dimensional structure, or the actual occurrence of the corresponding construction risk.

Internal consistency was assessed using Cronbach's alpha, with a minimum acceptable threshold of $\alpha > 0.60$, as adopted from the referenced methodological literature [9]. Cronbach's alpha measures the degree of covariance among questionnaire items and is influenced by both the number of items and their interrelationships. Although a higher coefficient generally indicates stronger internal consistency, it does not independently establish questionnaire unidimensionality, temporal stability, or the factual accuracy of respondent perceptions [10]. Reliability assessment was performed on the original 28-item questionnaire, and no separate Cronbach's alpha coefficient was calculated for the final set of 20 retained indicators.

2.5. Negative-Response Screening and Descriptive Data Analysis.

Following the preliminary instrument assessment, candidate indicators were evaluated using a predefined negative-response screening criterion. The threshold was established before examining the questionnaire results to maintain consistency in indicator selection. Negative responses were defined as the combined frequencies of strongly disagree and disagree. The percentage of negative responses for each indicator was calculated using Equation (1):

$$P^{-}_{i} = [(fSD,_i + fD,_i) / N_i] \times 100\%$$

where P^{-}_{i} represents the percentage of negative responses for indicator i; $fSD,_i$ and $fD,_i$ denote the frequencies of strongly disagree and disagree responses, respectively; and N_i) represents the total number of valid responses for the corresponding indicator.

An indicator was excluded when its negative-response percentage exceeded 50% ($P^{-}_{i} > 50$) and retained when the percentage was equal to or below 50% ($P^{-}_{i} \leq 50$). Given that all 27 respondents provided responses to each indicator, exclusion required at least 14 negative responses. Screening decisions were based on the original response frequencies rather than rounded percentages to ensure consistency and avoid classification errors. The screening criterion was designed to exclude indicators only when more than half of the respondents explicitly disagreed with the corresponding risk statement. A previous stakeholder report on vehicle–grid integration applied the classification of majority disagreement to cases in which negative responses exceeded 50% [11]. Although this reference illustrates the interpretation of

majority disagreement, it does not establish a universally accepted screening threshold for construction delay risks. Therefore, the application of the 50% criterion in the present study was treated as a project-specific operational decision intended for preliminary indicator screening.

Neutral responses were included in the denominator but were not classified as either positive or negative. Consequently, retaining an indicator indicated the absence of majority disagreement rather than confirmation of majority agreement or evidence of actual risk occurrence. To provide a more comprehensive interpretation of respondent perceptions, positive-response percentages, calculated from the combined frequencies of agree and strongly agree, and neutral-response percentages were reported alongside negative-response percentages. The descriptive analysis summarized response distributions and identified indicators retained under the predefined screening criterion. No inferential comparisons between occupational groups were performed, and no statistical causal analysis was conducted to determine whether the identified indicators contributed directly to the observed project progress deviation.

3. Results and Discussion

3.1. Respondent Profile.

The study involved 27 respondents representing various professional and operational positions within the research building construction project. The distribution of respondents according to their respective positions is presented in Table 1. Construction management personnel constituted the largest group, comprising five respondents (18.52%), followed by assistant steel foremen, with three respondents (11.11%). Seven professional positions were represented by two respondents each (7.41%), while five positions were represented by one respondent each (3.70%). The respondents included personnel responsible for project management, technical documentation, site supervision, procurement, logistics, occupational safety, and construction execution.

Table 1. Respondent Distribution by Professional Position.

Position	Number of respondents	Percentage (%)
Construction Management	5	18.52
Assistant Steel Foreman	3	11.11
Estimator	2	7.41
Drafter	2	7.41
Surveyor	2	7.41
Assistant Surveyor	2	7.41
Assistant Reinforcement Foreman	2	7.41
Assistant Finishing Foreman	2	7.41
Assistant Formwork Foreman	2	7.41
Site Manager	1	3.70
Safety and Health Officer	1	3.70
Procurement Personnel	1	3.70
Supervisor	1	3.70
Logistics Personnel	1	3.70
Total	27	100.00

The diversity of professional roles provided complementary perspectives on potential construction delay risks. Construction management personnel and the site manager were

involved in project planning and decision-making, whereas estimators, drafters, and surveyors contributed perspectives on technical requirements and site conditions. Procurement and logistics personnel were familiar with material availability and delivery processes, while supervisors and assistant foremen provided insights into daily construction activities and operational constraints. However, the study did not examine differences in perceptions across professional groups or assign weights to responses based on occupational positions. Consequently, the aggregated results represent the collective perceptions of the defined respondent group and should not be interpreted as identical assessments across all professional categories.

3.2. Validity and Reliability Test Results.

The questionnaire instrument was assessed for preliminary item validity and internal consistency before the screening of potential construction delay-risk indicators. Pearson product–moment correlation analysis was performed on the 28 candidate indicators using an adopted critical correlation coefficient of 0.381 at a significance level of 0.05. As presented in Table 2, the calculated item–total correlation coefficients ranged from 0.386 to 0.780, exceeding the established threshold. Therefore, all 28 indicators satisfied the study's operational item validity criterion and were retained for subsequent perception-based screening. Although all indicators exceeded the adopted correlation threshold, these findings should be interpreted cautiously. The analysis employed uncorrected item–total correlations, meaning that each indicator was included in the total score against which it was correlated. This procedure introduces part–whole overlap and may increase the observed correlation coefficients. Consequently, the results provide preliminary evidence of associations between individual items and the overall questionnaire score rather than comprehensive confirmation of construct validity or the actual occurrence of the proposed risks.

Table 2. Results of the Preliminary Item Validity Assessment.

Test parameter	Assessment criterion	Result	Interpretation
Pearson item–total correlation	Calculated r > 0.381	28 of 28 indicators met the criterion	All indicators satisfied the adopted preliminary validity criterion
Correlation coefficient range	r > 0.381	0.386–0.780	All coefficients exceeded the adopted critical value

Internal consistency was subsequently evaluated using Cronbach's alpha for the complete 28-item questionnaire. As shown in Table 3, the calculated Cronbach's alpha coefficient was 0.907, exceeding the adopted minimum criterion of 0.60. This result indicates a high degree of internal consistency among the questionnaire items within the observed dataset. Nevertheless, the coefficient should not be interpreted as evidence that all indicators measure a single underlying construct or that the corresponding construction risks occurred. The questionnaire covers four conceptually distinct risk categories, and the reported coefficient represents the combined instrument rather than the reliability of individual categories.

Table 3. Internal Consistency Assessment of the Questionnaire.

Reliability statistic	Number of items	Result	Adopted criterion
Cronbach's alpha	28	0.907	$\alpha > 0.60$

3.3. Identification and Screening of Delay-Risk Indicators.

The identification and screening of potential construction delay risks were conducted using responses to the 28 candidate indicators classified into technical, managerial, resource-related, and external categories. Each indicator was evaluated according to the predefined negative-response criterion, whereby indicators receiving more than 50% combined strongly disagree and disagree responses were excluded. The screening results, including the percentages of negative, neutral, and positive responses and the corresponding retention decisions, are presented in Table 4.

Table 4. Screening Results for the 28 Candidate Construction Delay-Risk Indicators (N = 27).

Code	Risk indicator	Category	Negative (%)	Neutral (%)	Positive (%)	Status
A1	Design changes during construction	T	0.00	22.22	77.78	Retained
A2	Repeated revisions to working drawings	T	22.22	33.33	44.44	Retained
A3	Discrepancies between working drawings and site conditions	T	88.89	11.11	0.00	Excluded
A4	Construction methods unsuitable for site conditions	T	22.22	40.74	37.04	Retained
A5	Poor coordination of structural, architectural, and MEP drawings	T	29.63	37.04	33.33	Retained
A6	Incomplete or insufficiently detailed shop drawings	T	22.22	37.04	40.74	Retained
A7	Delays in main activities affecting subsequent construction work	T	0.00	22.22	77.78	Retained
A8	Delays in shop drawing approval	T	74.07	25.93	0.00	Excluded
B1	Unrealistic project schedule	M	25.93	37.04	37.04	Retained
B2	Insufficiently detailed or controlled weekly/daily work plans	M	18.52	51.85	29.63	Retained
B3	Insufficient site supervision	M	81.48	18.52	0.00	Excluded
B4	Poor coordination among contractor, consultant, and owner	M	18.52	55.56	25.93	Retained
B5	Poor coordination among internal contractor departments	M	85.19	14.81	0.00	Excluded
B6	Delayed decisions by supervisors or project management	M	3.70	44.44	51.85	Retained
B7	Inconsistent progress monitoring	M	74.07	22.22	3.70	Excluded
B8	Poor site management	M	14.81	40.74	44.44	Retained
C1	Delayed material delivery to site	R	0.00	11.11	88.89	Retained
C2	Delivered material quantities not meeting site requirements	R	0.00	7.41	92.59	Retained
C3	Insufficient workforce	R	14.81	59.26	25.93	Retained
C4	Low labor productivity	R	85.19	7.41	7.41	Excluded
C5	Insufficient work guidance by foremen	R	85.19	14.81	0.00	Excluded
C6	Worker skills not suited to work requirements	R	25.93	44.44	29.63	Retained
C7	Breakdown of heavy equipment or work tools	R	0.00	18.52	81.48	Retained
D1	Adverse weather hindering site activities	E	11.11	37.04	51.85	Retained
D2	Difficult access to the project site	E	14.81	40.74	44.44	Retained
D3	Permit or bureaucratic obstacles	E	92.59	7.41	0.00	Excluded
D4	Disturbances from the surrounding project environment	E	0.00	44.44	55.56	Retained
D5	Unforeseen events or force majeure	E	18.52	33.33	48.15	Retained

Note: T = technical; M = managerial; R = resource-related; E = external. Negative = strongly disagree/disagree; positive = agree/strongly agree. Indicators with >50% negative responses were excluded. Percentages are rounded; screening used actual counts. Retention does not confirm risk occurrence or majority agreement.

Of the 28 candidate indicators, eight exceeded the negative-response threshold and were excluded. These comprised discrepancies between working drawings and site conditions (A3,

88.89%), delays in shop drawing approval (A8, 74.07%), insufficient site supervision (B3, 81.48%), poor coordination among internal contractor departments (B5, 85.19%), inconsistent progress monitoring (B7, 74.07%), low labor productivity (C4, 85.19%), insufficient work guidance by foremen (C5, 85.19%), and permitting or bureaucratic obstacles (D3, 92.59%). The high disagreement percentages indicate that most respondents did not endorse these statements as relevant descriptions of the investigated project. However, their exclusion does not establish that the corresponding risks were entirely absent.

The remaining 20 indicators satisfied the screening criterion and were retained, comprising six technical, five managerial, five resource-related, and four external indicators. The retained technical indicators were A1, A2, A4, A5, A6, and A7; managerial indicators were B1, B2, B4, B6, and B8; resource-related indicators were C1, C2, C3, C6, and C7; and external indicators were D1, D2, D4, and D5. Their negative-response percentages ranged from 0.00% to 29.63%, indicating that none was rejected by a majority of respondents. These indicators constitute a project-specific set of potential delay risks requiring further assessment rather than a list of independently verified causes of construction delays.

Among the retained indicators, material quantity discrepancies (C2) received the highest positive-response percentage, with 25 respondents (92.59%) selecting agree or strongly agree. This was followed by delayed material deliveries (C1), with 24 positive responses (88.89%), and equipment or work-tool breakdowns (C7), with 22 positive responses (81.48%). Design changes during construction (A1) and delays in main activities affecting subsequent construction work (A7) each received 21 positive responses (77.78%). These findings suggest that material-related constraints and equipment availability were among the most strongly endorsed potential delay risks in the investigated project. However, the percentages represent respondent agreement and should not be interpreted as measured risk probabilities, frequencies of occurrence, or causal contributions to the observed schedule deviation.

Importantly, the screening results also demonstrate that indicator retention does not necessarily imply majority agreement. Twelve of the 20 retained indicators received positive responses from no more than half of the respondents. For example, poor coordination among the contractor, consultant, and owner (B4) received 25.93% positive responses and 55.56% neutral responses. Similarly, insufficient workforce availability (C3) received 25.93% positive responses and 59.26% neutral responses. Although both indicators were retained because their negative-response percentages remained below the exclusion threshold, the substantial proportion of neutral responses indicates uncertainty or limited endorsement among respondents. Therefore, these indicators should be considered preliminary candidates for further investigation rather than confirmed project constraints.

3.5. Design Changes, Drawing Revisions and Activity Dependencies.

Design changes during construction (A1) and delays in main activities affecting subsequent work (A7) each received 77.78% positive responses. In contrast, repeated drawing revisions (A2) received 44.44% agreement, 33.33% neutral responses, and 22.22% disagreement. Although all three indicators were retained, the higher agreement percentages for A1 and A7 suggest stronger respondent endorsement of design changes and activity dependencies as potential construction delay risks compared with repeated drawing revisions.

Design changes may require revisions to technical drawings, coordination among engineering disciplines, adjustments to material quantities, or modifications to construction methods. When subsequent activities depend on the completion or approval of revised technical

information, unresolved changes may disrupt construction sequences and affect overall project progress. Similar design-related and implementation challenges have been reported in construction projects in Balikpapan, other building projects, and Bali [4–6]. However, the present findings reflect respondent perceptions and do not establish the timing, frequency, or causal contribution of drawing revisions to the observed progress shortfall.

The exclusion of drawing–site discrepancies (A3) and delayed shop drawing approval (A8) does not contradict the retention of design changes (A1) and repeated drawing revisions (A2). Design modifications may occur without discrepancies between drawings and actual site conditions, while drawing revisions do not necessarily result in delayed approvals. These indicators represent related but distinct technical processes. Further examination of change orders, drawing revision records, and approval timelines would provide additional evidence for determining their actual influence on construction progress.

3.6. Managerial Risks and Stakeholder Coordination.

Delayed decision-making by supervisors or project management (B6) received 51.85% agreement and only 3.70% disagreement, indicating majority endorsement among respondents. In comparison, insufficiently detailed or controlled weekly and daily work plans (B2) received 29.63% agreement, while poor coordination among contractors, consultants, and project owners (B4) received 25.93%. Although all three indicators satisfied the retention criterion, their different response distributions suggest varying levels of perceived relevance to the investigated project.

Delayed managerial decisions may disrupt construction activities when implementation teams require technical clarification, revised instructions, or authorization before proceeding with subsequent work. The duration of such delays may depend on communication efficiency, organizational responsibilities, decision-making authority, and the availability of supporting technical information. Previous studies have similarly identified inadequate planning, ineffective project management, and coordination problems as potential contributors to construction delays [1, 3–5]. Nevertheless, the present questionnaire did not identify the organizations responsible for specific decision delays or quantify their effects on project performance.

The distinction between interorganizational and internal contractor coordination is particularly important. Indicator B4 addresses coordination among contractors, consultants, and project owners, whereas B5 concerns coordination among departments within the contractor's organization. Therefore, the retention of B4 and exclusion of B5 are not contradictory, as coordination effectiveness may differ across organizational boundaries. Furthermore, respondents may have varying levels of involvement in, or knowledge of, these coordination processes. These findings highlight the importance of evaluating managerial risks according to their specific organizational contexts rather than treating coordination problems as a single, uniform factor.

3.7. Interpretation of Excluded Construction Delay-Risk Indicators.

Eight indicators were excluded because their negative-response percentages exceeded the predefined 50% threshold. These indicators included discrepancies between working drawings and site conditions (A3), delayed shop drawing approval (A8), insufficient site supervision (B3), poor internal contractor coordination (B5), inconsistent progress monitoring (B7), low

labor productivity (C4), insufficient foreman guidance (C5), and permitting or bureaucratic obstacles (D3). The excluded indicators generally exhibited high disagreement and limited positive endorsement. Specifically, inconsistent progress monitoring (B7) received only one positive response, while low labor productivity (C4) received two positive responses. The remaining six excluded indicators received no positive responses.

These response distributions indicate that most respondents did not perceive the excluded indicators as relevant descriptions of the investigated project's conditions. However, majority disagreement does not establish that the corresponding risks were entirely absent. The observed patterns may reflect relatively effective project controls, limited respondent exposure to specific operational processes, or differences in professional responsibilities and access to project information. Because these explanations were not independently investigated, the findings cannot confirm the effectiveness of supervision, internal coordination, progress monitoring, or permitting procedures.

An important distinction was observed among workforce-related indicators. Low labor productivity (C4) was excluded, whereas insufficient workforce availability (C3) and mismatches between worker competencies and assigned tasks (C6) were retained. These findings suggest that respondents distinguished workforce availability and skill suitability from labor productivity. Consequently, low labor productivity should not be identified as a dominant construction delay factor in this project based on the available evidence. Nevertheless, excluded indicators may remain relevant for subsequent project monitoring, particularly when infrequent events have the potential to generate substantial operational or schedule consequences. The screening results should therefore be interpreted as a preliminary assessment of perceived risk relevance rather than definitive evidence of risk absence or causal significance.

4. Conclusions

This study successfully identified the risks that cause delays in the implementation of research building construction projects, which were examined through a preliminary questionnaire distributed to 27 respondents and tested for validity (all 28 indicators were valid, calculated R > 0.381) and reliability (Cronbach’s Alpha = 0.907). Based on the elimination criterion of a 50% threshold for negative responses, 20 relevant risk indicators that actually occur in the field were identified, consisting of 6 technical risk indicators, 5 managerial risk indicators, 5 resource risk indicators, and 4 external risk indicators, while the other 8 indicators were removed because they were deemed unrelated to the project conditions. Risks such as delays in material delivery, material volumes that do not meet requirements, design changes during implementation, and delays in the main work that hold up subsequent technical work received the highest level of agreement among respondents, indicating that technical and resource risks are the most dominant factors contributing to delays in this project. These twenty risk indicators, which have been tested for validity and reliability, serve as the basis for further research to conduct a more in-depth risk analysis in order to formulate effective and prioritized mitigation strategies.

Competing Interests

The authors declare that they have no known financial or non-financial competing interests that could have influenced the research presented in this manuscript.

Author Contributions

Both authors contributed equally to the conceptualization, methodology, data collection, formal analysis, investigation, manuscript preparation, and review and editing. Both authors read and approved the final manuscript.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of AI-Assisted Technologies

Generative artificial intelligence (AI) tools were used solely to assist with language editing, grammar correction, and improving manuscript readability. The authors reviewed and verified the AI-assisted revisions and take full responsibility for the accuracy, originality, and integrity of the published content. AI tools were not used to generate, manipulate, or fabricate research data or results.

References

[1] Surri, D.A.; Alfianto, I. (2025). Faktor penyebab keterlambatan proyek infrastruktur di Indonesia dan strategi manajemen: Studi literatur. *Journal of Sustainable Construction*, *5*, 25–34. https://doi.org/10.26593/josc.v5i1.9253.

[2] Rauzana, A.; Zahrah, A.; Dharma, W. (2022). Critical delay factors for construction projects in Central Aceh District, Indonesia. *F1000Research*, *11*, 474. https://doi.org/10.12688/f1000research.110024.3.

[3] Jamal; Rezki Ian, M. (2025). Analisis faktor penyebab keterlambatan proyek konstruksi di Indonesia. *Jurnal Kajian Teknik Sipil*, *10*, 1–8. https://doi.org/10.52447/jkts.v10i1.8071.

[4] Putra, D.A.; Sari, O.L.; Situmorang, R. (2023). Analisis faktor keterlambatan proyek konstruksi di Kota Balikpapan. *Jurnal Teknik Sipil: Rancang Bangun*, *9*, 17–24. https://doi.org/10.33506/rb.v9i1.2044.

[5] Megawati, L.A.; Lirawati. (2021). Analisis faktor keterlambatan proyek konstruksi bangunan gedung. *Jurnal Teknik: Majalah Ilmiah Fakultas Teknik UNPAK*, *21*. https://doi.org/10.33751/teknik.v21i2.3282.

[6] Sari, O.L.; Saputra, A.A.I.; Abidah, Z. (2021). Analisa faktor penyebab keterlambatan pada proyek pembangunan villa dan hotel ABC di Bali. *Jurnal Manajemen Aset Infrastruktur & Fasilitas*, *5*. https://doi.org/10.12962/j26151847.v5i3.15359.

[7] Adriadi; Solihin, A.R. (2021). Faktor-faktor penyebab keterlambatan proyek konstruksi gedung. *Prosiding Seminar Nasional Ketekniksipilan, Infrastruktur dan Industri Jasa Konstruksi (KIIJK), 1,* 451–461..

[8] Amin, N.F.; Garancang, S.; Abunawas, K. (2023). Konsep umum populasi dan sampel dalam penelitian. *PILAR*, *14*, 15–31.

[9] Anggraini, F.D.P.; Aprianti, A.; Setyawati, V.A.V.; Hartanto, A.A. (2022). Pembelajaran statistika menggunakan software SPSS untuk uji validitas dan reliabilitas. *Jurnal Basicedu*, *6*, 6491–6504. https://doi.org/10.31004/basicedu.v6i4.3206.

[10] Tavakol, M.; Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd.

[11] Final Report of the California Joint Agencies Vehicle-Grid Integration Working Group; Gridworks: Oakland, CA, USA. (accessed on 1 August 2026) Available online:

https://www.gridworks.org/wp-content/uploads/2020/09/GW_VehicleGrid-Integration-Working-Group.pdf.



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