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The Application of Content Validity Index in Identifying and Validating Material Delay Risks in Sorong Construction Projects

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ABSTRACT: Material delays remained one of the most critical challenges affecting the performance of construction projects in Sorong, Southwest Papua, where geographical isolation, limited logistics capacity, and supply-chain disruptions frequently extended project timelines. This study aimed to identify and validate a context-specific list of material delay risks by applying the Content Validity Index (CVI) to ensure that the selected risk indicators accurately represented the conditions of construction projects in the region. A descriptive–qualitative approach was employed, involving eight experts with a minimum of five years of experience in construction project management in Southwest Papua. Twenty-nine risk events and twenty risk agents derived from the literature were assessed using a 1–4 relevance scale. The results indicated that 14 risk events and 13 risk agents achieved acceptable validity, with I-CVI values ranging from 0.88 to 1.00. The high S-CVI/Ave (0.98) and S-CVI/UA (0.87 for risk events; 0.86 for risk agents) demonstrated strong consensus among experts and confirmed the robustness of the research instrument. These findings suggested that the validated risk list accurately reflected dominant material delay issues in Sorong and was appropriate for subsequent quantitative risk analysis. The validated items were further interpreted as essential inputs for the next phase of research, particularly in applying Failure Mode and Effect Analysis (FMEA) and the House of Risk (HOR) to prioritize dominant risk agents and develop targeted mitigation strategies. This study recommended broadening expert representation in future validations and integrating digital early-warning systems to strengthen material management practices in the region. The validated risk framework provided practical implications for contractors, policymakers, and supply-chain stakeholders in improving project reliability in Sorong.

KEYWORDS: Content Validity Index; material delay risk; construction project; Sorong; expert validation.

1. Introduction

Construction delays remain a chronic issue that systematically erodes project timelines, budgets, and the successful delivery of infrastructure, particularly in regions characterized by harsh logistical and geographical barriers [1, 2]. Within this complex landscape, material disruptions are frequently cited as the most volatile factor, given their immediate influence on procurement cycles, transportation bottlenecks, and on-site readiness [3−5]. This challenge is particularly acute in Southwest Papua, where construction projects are hampered by geographical isolation, heavy reliance on maritime shipping, and a chronic shortage of locally sourced materials. Data from BPS Papua Barat (2023) indicate that over 90% of building projects in the region experience delays, with supply chain failures at the heart of the problem. In Sorong specifically, lead times for essential materials often extend to 45–60 days, creating a ripple effect of schedule uncertainty and rising costs (Dishub Papua Barat, 2024). While earlier research has highlighted logistics dependency and contractor capacity as primary culprits, the unique institutional environment of the region necessitates a more nuanced investigation [6, 7].

Although established quantitative tools such as FMEA and the HOR have been widely used to rank these risks [8–11], much of this research relies on generic indicators borrowed from unrelated contexts. This "one-size-fits-all" approach assumes that risk factors are universal, often overlooking the specific logistical and institutional nuances that define a unique region like Southwest Papua [12, 13]. There is, therefore, a pressing need to ensure that risk indicators are contextually grounded before they are quantified. This study addresses that gap by positioning the CVI as a mandatory precursor to FMEA and HOR analysis. By subjecting risk events and agents to rigorous expert scrutiny, the CVI ensures that only the most relevant, context-specific factors are carried forward. This methodology not only strengthens the rigor of risk identification but also significantly improves the reliability of subsequent quantitative modeling. In light of this, the present study aims to build a scientifically validated, context-aware instrument for assessing material delay risks in the building sector of Sorong, Southwest Papua. By establishing this validated list, the research provides a foundation for more accurate FMEA- and HOR-based mitigation strategies in the future.

2. Materials and Methods

2.1. Research design and expert selection.

To strengthen the validation process, this research combined qualitative insights with quantitative CVI metrics, creating a more robust analytical framework. A group of eight specialists was intentionally selected through purposive sampling, targeting individuals with at least five years of experience managing construction operations in the unique environment of Southwest Papua. This selection follows the benchmarks established by Lynn [14] and Polit and Beck [15, 16], which indicate that a panel of six to ten experts represents the 'sweet spot' for stable CVI results—particularly when enforcing a rigorous 0.83 I-CVI cutoff. By drawing from a mix of contractors, consultants, and project managers, the study captured a broad spectrum of professional expertise, helping to neutralize personal biases and ensuring that the data accurately reflected field realities.

2.2. Theoretical basis of the CVI.

To quantify the alignment between instrument items and their underlying constructs, the CVI was employed as a measure of expert consensus [15, 16]. The CVI is particularly advantageous in the preliminary stages of tool development or in specialized, context-heavy research where localized expert knowledge is critical [17, 18]. In contrast to more expansive statistical methods such as factor analysis, the CVI provides a clear and practical framework that retains its value even in data-limited or remote geographical contexts [15]. This approach has gained significant traction in construction research, where it is frequently used to verify the integrity of instruments focused on quality assurance, safety standards, and risk mitigation strategies [19, 20].

2.3. Instrument development and expert assessment.

Starting with a preliminary inventory of 29 risk events (Table 1) and 20 risk agents (Table 2), these indicators were refined through an extensive literature review tailored to the Sorong context. Experts then appraised each item using a standardized four-point relevance scale, where 1 represented "not relevant" and 4 signified "highly relevant," in accordance with established CVI protocols. The systematic progression of this assessment and the overall research trajectory are visualized in Figure 1.

Table 1. Initial list of risk events for expert validation.

Code	Risk Event	Relevance Scale (1–4)
E1	Errors in purchase requests	① ② ③ ④
E2	Failure to control the schedule of purchase requests	① ② ③ ④
E3	Delays in material and component procurement processes	① ② ③ ④
E4	Communication and coordination failures among project stakeholders	① ② ③ ④
E5	Additional material orders due to specification changes	① ② ③ ④
E6	Additional material orders due to changes in room function	① ② ③ ④
E7	Additional material orders caused by sudden design changes by the owner	① ② ③ ④
E8	Difficulty in sourcing materials	① ② ③ ④
E9	Delays in material delivery due to financial issues	① ② ③ ④
E10	Re-delivery of materials due to discrepancies between drawings and received specifications	① ② ③ ④
E11	Changes in material orders due to inaccurate contractor scheduling	① ② ③ ④
E12	Insufficient managerial capabilities of subcontractors	① ② ③ ④
E13	Negligence of subcontractors or contractors in material handling	① ② ③ ④
E14	Materials arriving too early due to inaccurate ordering time	① ② ③ ④
E15	Re-delivery of materials due to unclear work instructions	① ② ③ ④
E16	Changes in material orders due to schedule mismatches	① ② ③ ④
E17	Delayed payment from main contractor to subcontractor	① ② ③ ④
E18	Delays in material orders due to late submission of shop drawings	① ② ③ ④
E19	Difficulty obtaining materials due to limited local stock	① ② ③ ④
E20	Material delivery delays from outside Southwest Papua	① ② ③ ④
E21	Difficult access to project location	① ② ③ ④
E22	Limited capacity of material transport equipment	① ② ③ ④
E23	Inoperable transport equipment	① ② ③ ④
E24	Security disruptions during material delivery	① ② ③ ④
E25	Delivery delays caused by vendor constraints	① ② ③ ④
E26	Overstock of materials in the warehouse	① ② ③ ④
E27	Delayed payment to vendor due to incomplete administration	① ② ③ ④
E28	Insufficient material availability	① ② ③ ④
E29	Mid-project changes in material specifications	① ② ③ ④

Table 2. Initial list of risk agents for expert validation.

Code	Risk Agent	Relevance Scale (1–4)
A1	Unpredictable weather conditions	① ② ③ ④
A2	Errors and delays in decision-making	① ② ③ ④
A3	Poor relationships among owner, consultant, and contractor	① ② ③ ④
A4	Lack of experienced designers	① ② ③ ④
A5	Bureaucratic and lengthy permit approval processes	① ② ③ ④
A6	Design changes from the owner	① ② ③ ④
A7	High dependency on out-of-island vendors	① ② ③ ④
A8	Weaknesses in logistics planning	① ② ③ ④
A9	Prolonged technical evaluations	① ② ③ ④
A10	Disputes among project actors	① ② ③ ④
A11	Ineffective workforce performance	① ② ③ ④
A12	Incomplete documentation	① ② ③ ④
A13	Difficulty in sourcing raw materials	① ② ③ ④
A14	Inaccurate vendor selection	① ② ③ ④
A15	Logistical disruptions due to social or political factors	① ② ③ ④
A16	Incompetent workforce	① ② ③ ④
A17	Inaccuracy in material purchase planning	① ② ③ ④
A18	Transport equipment no longer meeting standards	① ② ③ ④
A19	Excessive time required for planning	① ② ③ ④
A20	Urgent demand for large quantities of raw materials	① ② ③ ④

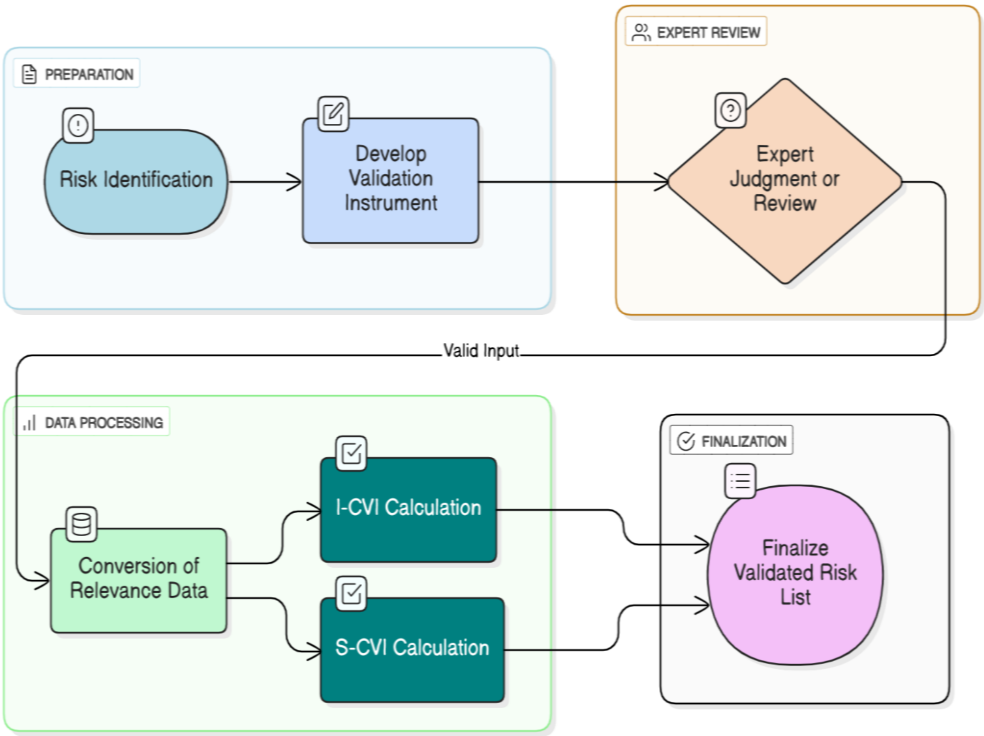

Figure 1. Research flowchart for the CVI procedure and expert validation process.

2.4. Data processing and decision rules.

To quantify expert feedback, ratings were transformed into binary values: scores of 3 and 4 were designated as "relevant" (1), while scores of 1 and 2 were classified as "not relevant" (0) [15, 16]. We determined the Item-level CVI (I-CVI) by calculating the proportion of experts who deemed an item relevant relative to the total panel size. In line with established benchmarks for panels comprising six or more experts, any item with an I-CVI below 0.83 was removed from the set [17, 18]. Furthermore, the overall scale-level validity was assessed through S-CVI/Ave and S-CVI/UA metrics. The specific benchmarks used to interpret the CVI results are outlined in Table 3.

Table 3. CVI threshold criteria based on the number of experts.

Number of Experts	Minimum CVI Value	Reference
2	0.8	[22]
3–5	1	[21, 24]
6 or more	0.83	–
Up to 8 experts	0.83	[23]

3. Results and Discussion

3.1. Expert judgment questionnaire.

In an effort to sharpen the study's focus, we tailored an expert judgment questionnaire to rigorously evaluate the specific risk events and agents responsible for material bottlenecks in Sorong's building industry. Rather than relying on generic metrics, each specialist assessed the indicators using a four-point Likert scale, where higher scores served as a proxy for how closely each risk reflected the 'on-the-ground' realities of local project environments. This validation was not merely a formality; it acted as an essential filter to verify the accuracy and local relevance of the data before proceeding to the primary collection phase [19–23]. Emphasizing expert agreement during this phase allowed the final instrument to be customized, ensuring it aligned with the distinct logistical complexities unique to Southwest Papua.

3.2. Analysis results.

The analysis examined the validity of 29 risk events and 20 risk agents derived from previous literature and adapted to the regional context. Eight experts provided relevance ratings using a four-point Likert scale. Consistent with CVI guidelines [15–17], all Likert-scale responses were converted into binary data, with scores of 3 and 4 indicating relevance (coded as 1) and scores of 1 and 2 indicating non-relevance (coded as 0). This conversion enabled an objective measurement of each item's content validity. The results of the expert assessment for risk events are presented in Table 4, while results for risk agents are presented in Table 5. Both tables include the number of experts agreeing on each item's relevance and the corresponding Item-level I-CVI. Items falling below the minimum I-CVI threshold of 0.83 were categorized as non-valid and excluded to preserve the overall validity and accuracy of the risk instrument [15, 17, 18]. The results indicate that not all items achieved sufficient expert consensus. Several risk events (E9, E10, E11, E14, E15, E17, E18, E20, E22, E23, E26, E27, E28, E29) and several risk agents (A4, A12, A13, A18, A19, A20) did not meet the minimum CVI requirement, with I-CVI values ranging from 0.13 to 0.75. These items were excluded from the final list, as their low consensus could compromise the instrument's content validity and reduce its contextual accuracy for the Sorong construction environment.

Table 4. Relevance of risk event items.

Code	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Experts Agree	I-CVI	Category
E1	1	1	1	1	1	1	1	1	8	1	Relevant
E2	1	1	1	1	1	1	1	1	8	1	Relevant
E3	1	1	1	1	1	1	1	0	7	0.88	Relevant
E4–E8 (all 1.00)	All experts scored relevant									1	Relevant
E9	0	1	1	1	0	0	1	1	5	0.63	Not Relevant

Code	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Experts Agree	I-CVI	Category
E10	0	0	0	1	0	1	1	1	4	0.5	Not Relevant
E11	0	1	1	1	0	1	1	0	5	0.63	Not Relevant
E12	1	1	1	1	1	1	1	1	8	1	Relevant
E13	1	1	1	1	1	1	1	1	8	1	Relevant
E14	0	1	1	0	0	1	0	0	3	0.38	Not Relevant
E15	0	1	1	1	0	1	0	1	5	0.63	Not Relevant
E16	0	1	1	1	1	1	1	1	7	0.88	Relevant
E17	0	0	1	1	1	1	1	0	5	0.63	Not Relevant
E18	0	0	1	1	1	1	1	0	5	0.63	Not Relevant
E19	1	1	1	1	1	1	1	1	8	1	Relevant
E20	0	1	0	1	1	0	1	1	5	0.63	Not Relevant
E21	1	1	1	1	1	1	1	1	8	1	Relevant
E22	0	1	1	1	0	1	1	0	5	0.63	Not Relevant
E23	0	1	0	1	1	1	0	1	5	0.63	Not Relevant
E24	1	1	1	1	1	1	1	1	8	1	Relevant
E25	1	1	1	1	1	1	1	1	8	1	Relevant
E26	0	0	0	0	0	1	0	0	1	0.13	Not Relevant
E27	0	0	1	1	0	1	1	1	5	0.63	Not Relevant
E28	0	1	0	0	0	1	1	0	3	0.38	Not Relevant
E29	0	1	1	1	0	0	1	0	4	0.5	Not Relevant

Table 5. Relevance of risk agent items.

Code	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Experts Agree	I-CVI	Category
A1	1	1	1	1	1	1	1	1	8	1	Relevant
A2	1	1	1	1	1	1	1	1	8	1	Relevant
A3	1	1	1	1	1	1	1	1	8	1	Relevant
A4	0	0	1	1	1	1	1	0	5	0.63	Not Relevant
A5	1	1	1	1	1	1	1	1	8	1	Relevant
A6	0	1	1	1	1	1	1	1	7	0.88	Relevant
A7	1	1	1	1	0	1	1	1	7	0.88	Relevant
A8–A11 (all 1.00)	All experts scored relevant									1	Relevant
A12	0	1	1	1	0	1	1	1	6	0.75	Not Relevant
A13	0	1	1	1	0	1	1	0	5	0.63	Not Relevant
A14–A17 (all 1.00)	All experts scored relevant									1	Relevant
A18	0	0	1	0	1	1	1	1	5	0.63	Not Relevant
A19	0	0	1	1	1	1	1	1	6	0.75	Not Relevant
A20	1	0	1	1	0	1	1	1	6	0.75	Not Relevant

3.3. Interpretation and development of the final risk list.

After calculating the I-CVI values, only items with I-CVI ≥ 0.83 were retained for the final validated list. The selected risk events and agents are presented in Table 6 and Table 7, along with the Universal Agreement (UA) index and overall S-CVI/Ave and S-CVI/UA values [17, 18]. The validation process produced a refined set of 15 risk events and 14 risk agents, with I-CVI scores ranging from 0.88 to 1.00, indicating strong expert consensus. An S-CVI/Ave of 0.98 for both categories highlights the panel's consistency, while S-CVI/UA values of 0.87 for risk events and 0.86 for agents confirm broad agreement on the relevance of these indicators [18, 24]. The results suggest that the validated risks reflect actual, recurring bottlenecks in Southwest Papua's construction sector. Key factors—including procurement failures, logistical challenges, contractor performance issues, and stakeholder misalignment—directly mirror the region's geographical and supply-chain complexities noted in prior studies [7, 10, 25−30]. This validated inventory now provides a high-fidelity foundation for the next research phase: risk prioritization using FMEA [11, 12] and the HOR framework [13, 14]. These methods are widely used in construction to identify high-impact risks and guide targeted mitigation [31, 32]. Beyond research implications, the findings offer practical benefits. Contractors can use the data to improve material controls, local authorities can reassess regional infrastructure policies, and supply-chain stakeholders can enhance vendor coordination, contributing to a more resilient flow of materials into Sorong.

Table 6. Final validated risk event list.

Code	Experts Agree	I-CVI	Category	UA
E1	8	1	Relevant	1
E2	8	1	Relevant	1
E3	7	0.88	Relevant	0
E4	8	1	Relevant	1
E5	8	1	Relevant	1
E6	8	1	Relevant	1
E7	8	1	Relevant	1
E8	8	1	Relevant	1
E12	8	1	Relevant	1
E13	8	1	Relevant	1
E16	7	0.88	Relevant	0
E19	8	1	Relevant	1
E21	8	1	Relevant	1
E24	8	1	Relevant	1
E25	8	1	Relevant	1

Table 7. Final validated risk agent list.

Code	Experts Agree	I-CVI	Category	UA
A1	8	1	Relevant	1
A2	8	1	Relevant	1
A3	8	1	Relevant	1
A5	8	1	Relevant	1
A6	7	0.88	Relevant	0
A7	7	0.88	Relevant	0
A8	8	1	Relevant	1
A9	8	1	Relevant	1
A10	8	1	Relevant	1
A11	8	1	Relevant	1
A14	8	1	Relevant	1
A15	8	1	Relevant	1
A16	8	1	Relevant	1
A17	8	1	Relevant	1

3.4. Interpretation of validated and excluded risks.

The validated risks are largely centered on procurement failures, logistical bottlenecks, restricted site access, and external shocks. These outcomes resonate with existing literature on Papua and other isolated territories, where a heavy reliance on fragile supply chains remains the primary driver of project delays [7, 10, 24, 25, 29, 30]. Interestingly, certain risks typical of urban construction such as warehouse overcrowding or premature material arrival [27, 28], failed to meet the validation threshold and were subsequently discarded. This divergence emphasizes why a generic approach is insufficient; it proves that the CVI serves as a vital methodological filter, successfully stripping away irrelevant indicators that do not reflect the ground realities of Sorong's unique industrial landscape.

3.5 Implications for regional construction practice.

This validated risk inventory functions as a tactical roadmap for contractors, enabling them to refine procurement workflows, synchronize supplier communications, and integrate realistic schedule buffers for high-risk inventory. At a broader scale, these results provide a data-driven baseline for policymakers looking to modernize infrastructure and de-bottleneck inter-island logistics. Simultaneously, the insights arm suppliers with the foresight required to anticipate market shifts and stabilize delivery performance in an otherwise volatile environment.

3.6. Transition to FMEA and HOR analysis.

Following the CVI validation, the identified risk events will function as failure modes in the upcoming FMEA analysis. Similarly, the validated risk agents will provide the foundation for measuring severity, frequency, and detection levels. The HOR framework will then be deployed to rank the most critical risk agents and develop high-impact mitigation tactics [13–16, 31, 32]. Integrating the CVI with FMEA and HOR frameworks does more than just quantify risk; it fundamentally elevates the precision and practical value of the entire management cycle.

4. Conclusions

This study highlights why rigorous content validation is indispensable when navigating the risk landscape of geographically isolated construction sites. By utilizing the CVI, we have moved beyond generic indicators to build a risk profile for Sorong that is as methodologically robust as it is contextually relevant. The exceptional S-CVI/Ave and S-CVI/UA metrics do more than just provide numbers; they validate the panel's shared expertise and the high internal consistency of the research tool itself. The data ultimately identifies procurement failures, logistical bottlenecks, and external shocks as the primary drivers of project delays in this region. While the findings are inherently tied to the local geography and the size of the expert panel, the underlying methodology offers a versatile and scalable blueprint for risk assessment in other resource-constrained settings. Moving forward, the next logical step is to bridge these insights with probabilistic weighting, utilizing FMEA and HOR to transform this validated data into actionable, high-impact mitigation strategies. The findings provide practical value for contractors, suppliers, and policymakers seeking to improve construction performance in remote regions.

Author Contributions

Yohanes Deocaeso Nataputra Prayogo: Conceptualization, methodology design, data curation, formal analysis, manuscript drafting, and validation. Nectaria Putri Pramesti: Supervision, critical review and editing, theoretical refinement, and methodological validation.

Data Availability Statement

The data supporting the findings of this study—including expert judgment scoring sheets, CVI calculations, and validated risk matrices—are available from the corresponding author upon reasonable request.

Competing Interest

The authors declare that they have no known financial, professional, or personal conflicts of interest that could have influenced the work reported in this study.

References

[1] Latif, M. (2023). Analyzing the Key Factors Contributing to Project Delays in the Construction Industry. *Journal of Development and Social Sciences, 4*(3), 936–944. https://doi.org/10.47205/jdss.2023(4-III)85.

[2] Durdyev, S.; Hosseini, M. R. (2020). Causes of delays on construction projects: A comprehensive list. *International Journal of Managing Projects in Business, 13*(1), 20–46. https://doi.org/10.1108/IJMPB-09-2018-0178.

[3] Reddy, M. V.; Rao, H. (2022). Analysing the critical delay factors and delay in material supply for construction projects in India. *Materials Today: Proceedings, 60*(3), 1890–1897. https://doi.org/10.1016/j.matpr.2021.12.529.

[4] Sanni-Anibire, M. O.; Zin, R. M.; Olatunji, S. O. (2020). Causes of delay in the global construction industry: A meta analytical review. *International Journal of Construction Management, 22*(8), 1395–1407. https://doi.org/10.1080/15623599.2020.1716132.

[5] Wuala, H. D.; Rarasati, A. D. (2020). Causes of delays in construction project for developing Southeast Asia countries. *IOP Conference Serries: Materials Science and Engineering, 830*(2), 022054. https://doi.org/10.1088/1757-899X/830/2/022054.

[6] Joseph, A.; Soekiman, A.; Siregar, C. A. (2025). The Influence of Internal and External Factors on the Delays of Government Construction Projects in West Papua Province. Morfai Journal, 5(1), 527–534. https://doi.org/10.54443/morfai.v5i1.2662.

[7] Lokobal, A.; Marthin, R.; Sumajouw, D. J.; Sompie, B. F. (2014). Manajemen Risiko pada Perusahaan Jasa Pelaksana Konstruksi di Propinsi Papua. *Jurnal Ilmiah Media Engineering, 4*(2), 109–118.

[8] Santosa, B.; Muttaqin, P. S.; Sukmawati, S. I. (2024). Operational Risk Analysis of Steel Warehouses Using Failure Mode and Effect Analysis. *Motivection, 6*(1), 101–114. https://doi.org/10.46574/motivection.v6i1.315.

[9] Karamoozian, A.; Wu, D. (2020). A hybrid risk prioritization approach in construction projects using failure mode and effect analysis. *Engineering, Construction and Architectural Management, 27*(9), 2661–2686. https://doi.org/10.1108/ECAM-10-2019-0535.

[10] Dvaipayana, M. A. T.; Sriwana, I. K.; Prambudia, Y. (2024). Design of Supply Chain Risk Mitigation System Using House of Risk and Fuzzy AHP Methods in Precast Concrete. *Sinergi, 28*(1), 93–102. https://doi.org/10.22441/sinergi.2024.1.010.

[11] Lantana, M. G.; Vikaliana, R.; Kurnia, G. (2024). Mitigasi Risiko Pengadaan Bahan Baku dengan Metode House of Risk (HOR). *Terapan Informatika Nusantara, 4*(9), 544–558. https://doi.org/10.47065/tin.v4i9.4873.

[12] Acebes, F.; González-Varona, J. M.; López-Paredes, A.; et al. (2024). Beyond probability–impact matrices in project risk management: A quantitative methodology for risk prioritisation. *Humanities and Social Sciences Communications, 11,* 670. https://doi.org/10.1057/s41599-024-03180-5.

[13] Kumi, L.; Jeong, J.; Jeong, J. (2024). Systematic Review of Quantitative Risk Quantification Methods in Construction Accidents. *Buildings, 14*(10), 3306. https://doi.org/10.3390/buildings14103306.

[14] Lynn, M. R. (1986). Determination and Quantification of Content Validity. *Nursing Research, 35*(6), 382–386.

[15] Polit, D. F.; Beck, C. T. (2006). The Content Validity Index: Are You Sure You Know What's Being Reported? *Research in Nursing & Health, 29*(5), 489–497. https://doi.org/10.1002/nur.20147.

[16] Polit, D. F.; Beck, C. T.; Owen, S. V. (2007). Is the CVI an Acceptable Indicator of Content Validity? Research in Nursing & Health, 30(4), 459–467. https://doi.org/10.1002/nur.20199.

[17] Shash, A. A.; AbuAlnaja, F. M. (2021). Causes of material delays in capital projects in Saudi Arabia. *International Journal of Construction Management, 23*(7), 1109–1117. https://doi.org/10.1080/15623599.2021.1956294.

[18] Howay, F.; Ashad, H. (2025). Analisis Risiko Material dalam Proyek Konstruksi. *TESLINK, Special Volume*, 340–355. https://doi.org/10.52005/teslink.v115i1.xxx.

[19] Mudjanarko, S. W. (2025). The Influence of Materials and Natural Constraints on Mobilization and Timeliness of Road Improvement Projects in Papua. *Smart Construction Journal, 8*(2). https://doi.org/10.29138/scj.v8i2.3259.

[20] Ariyanto, A. S.; Kamila, K. A. P.; Supriyadi, S.; Utomo, M. B.; Mahmudi, W. L. (2023). Pengaruh Keterlambatan Material terhadap Risiko Proyek Pembangunan Gedung Parkir. *Bangun Rekaprima, 5*(2), 1575. https://doi.org/10.32497/bangunrekaprima.v5i2.1575.

[21] Khursheed, S.; Sharma, S.; Paul, V. K.; Alzubaidi, L. H.; Israilova, D. (2024). Review of the Factors Inducing Delay in Construction Project Material Management. *E3S Web of Conferences, 563,* 02044. https://doi.org/10.1051/e3sconf/202456302044.

[22] Neroslavsky, I. (2023). Risk prioritizing method at the stage of qualitative risk analysis in project implementation. *International Journal of Accounting, Finance and Risk Management, 8*(2), 43–48. https://doi.org/10.11648/j.ijafrm.20230802.12.

[23] Bajpai, A.; Misra, S. C.; Kim, D. Y. (2023). Identification and assessment of risks related to digitalization in Indian construction. *Business Process Management Journal, 29*(4), 965–990. https://doi.org/10.1108/BPMJ-11-2022-0571.

[24] Davis, L. L. (1992). Instrument Review: Getting the Most From a Panel of Experts. *Applied Nursing Research, 5*(4), 194–197. https://doi.org/10.1016/S0897-1897(05)80008-4.

[25] Del Monte, M.; Spacco, G.; Pintabona, A.; et al. (2025). Development and content validation of the Insulin Pump Infusion Sets Satisfaction Scale (IPISS). *Diabetology, 6,* 110. https://doi.org/10.3390/diabetology6100110.

[26] Mota, J.; Martins, J.; Onofre, M. (2021). Portuguese Physical Literacy Assessment Questionnaire (PPLA-Q). *BMC Public Health, 21,* 2183. https://doi.org/10.1186/s12889-021-12230-5

[27] Raadabadi, M.; Rashidpour, P.; Alavi, Z. S.; Keshmiri, F. (2025). Development of Program Evaluation Framework of Clinical Education Based on 4C/ID: A Validation Study. *DSME, 12*(1), 23–32.

[28] Park, J.; Lee, Y. (2025). Content validity verification of a data collection tool for participatory design. *International Journal of Asia Digital Art and Design Association, 29*(1), 9–16. https://doi.org/10.20668/adada.29.1_9.

[29] Zawawi, M. H.; Azman, N. S.; Ramli, M. Z.; Roslin, N. T. (2020). Content validity of construction quality management of IBS-related project in Malaysia. *AIP Conference Proceedings, 2291*, 020086. https://doi.org/10.1063/5.0027056.

[30] Bajjou, M. S.; Chafi, A. (2018). Empirical study of schedule delay in Moroccan construction projects. *International Journal of Construction Management, 20*(7), 783–800. https://doi.org/10.1080/15623599.2018.1484859.

[31] Tafesse, S. (2021). A Review on the Critical Factors Causing Delay of Delivery Time in Construction Projects. *International Journal of Engineering Technologies, 6*(4), 69–81. https://doi.org/10.19072/ijet.815025.

[32] Kassem, M. A.; Khoiry, M. A.; Hamzah, N. (2020). Using Relative Importance Index Method for Developing Risk Map in Oil and Gas Construction Projects. *Jurnal Kejuruteraan, 32*(3), 441–453. https://doi.org/10.17576/jkukm-2020-32(3)-09.