



Quantitative Analysis of Partnering Depth between Designers and Contractors in Government Design and Build Projects

Achmad Sutowo¹ Agustinus Purna Irawan², Endah Murtiana Sari³ and Oei Fuk Jin⁴

¹Civil Engineering Doctoral Program, Faculty of Engineering, Universitas Tarumanagara, Jakarta Barat 11440

²School of STEM, Universitas Prasetya Mulya, Jakarta 12430, Indonesia

³Industrial Engineering, Universitas Sains Indonesia, Bekasi, Indonesia

⁴endah.murtiana@sains.ac.id

Received : 23 September 2026 Revised : 17 Oktober 2026 Accepted : 28 Oktober 2026

Abstract

This study aims to develop a quantitative model for measuring the depth of partnering between designers and contractors in government projects using the Design and Build scheme. Partnering is an important aspect because the integration of design and construction functions requires collaboration, communication, trust, and alignment of objectives among organizations. This study employed a quantitative approach through a survey of 50 respondents consisting of designers, contractors, and government project owners selected using purposive sampling. The depth of partnering was measured based on relationship factors, process factors, and environmental factors mediated by partnering maturity. Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) through validity testing, reliability testing, and descriptive statistical analysis to identify the characteristics and contribution of factors forming the depth of partnering. The results showed that the process factor (X2) had a standard deviation value of 2.01 and received strong attention in forming the depth of partnering. This finding indicates the importance of coordination among parties, risk sharing, quality control, and stakeholder involvement during the implementation of government Design and Build projects.

Keywords: Design and Build, Government Project, Partnering, Designer-Contractor, SPSS

© Diterbitkan oleh Jurnal Teknik Sipil Cendekia 2026. This article is distributed under a Creative Commons Attribution-ShareAlike 4.0 International License.

INTRODUCTION

Government construction projects have a high level of complexity because they involve multiple parties, regulatory requirements, accountability demands, and performance targets that must be achieved simultaneously. Under the Design and Build scheme, the design and construction processes are integrated within a single project delivery arrangement, making integration between designers and contractors particularly important. The implementation of the Design and Build

method in Indonesian government projects still faces various challenges, including regulatory aspects, organizational capacity, management, inter-organizational communication, and stakeholder support [1]. Unlike the Design-Bid-Build approach, which separates the design and construction processes, Design and Build requires more integrated working relationships and coordination among the parties involved [1],[2],[3]. Previous research on partnering in Design and Build projects has also shown that the relationship between contractors and designers is an important

aspect that needs to be considered in the implementation of this project delivery method [2].

Under these conditions, partnering can be regarded as a management approach that promotes more collaborative working relationships among project participants. Partnering encompasses aspects such as trust, communication, commitment, coordination, information openness, goal alignment, and joint problem solving [4]. In an integrated project delivery approach, communication and collaboration among owners, designers, and contractors are important elements in establishing working relationships to achieve common project objectives. Mentari and Mutaqi [5] demonstrated that communication and collaboration are important aspects of Integrated Project Delivery, with relationships developed through mutual respect, trust, transparency, and the involvement of project parties from the early stages of the project.

In this context, the depth of partnering does not merely indicate the existence or absence of cooperation but also reflects the development of relationships among project parties from transactional interactions toward higher levels of coordination, collaboration, and integration. Thohirin et al. [6] explained that partnering in the construction industry is needed to deepen interactions and improve communication among stakeholders [7]. Their study also demonstrated the need to develop tools and techniques for measuring partnering depth in construction projects so that collaborative relationships can be developed to support improved project performance.

In government Design and Build projects, decisions made during the design stage may affect construction methods, cost, quality, time, safety, and project risks. This condition makes active involvement among designers, contractors, owners, and other stakeholders important. Iqbal and Susanto [8] showed that active stakeholder involvement and collaboration from the early design stage are important aspects in creating an integrated design process. Previous research on contractor–designer partnering in Design and Build projects has also indicated that such relationships can be examined through

relationship, process, and environmental factors that shape interorganizational interactions [2].

Previous studies have examined contractor–designer partnering in Design and Build projects [2], the measurement of partnering depth [6], and tools and techniques for improving partnering maturity in Indonesian construction projects [9]. These studies provide a foundation for understanding the factors and maturity levels associated with collaborative relationships in construction. However, the present study addresses the need to operationalize partnering depth in the specific context of government Design and Build projects through an integrated measurement framework encompassing relationship factors (X1), process factors (X2), and environmental factors (X3), alongside partnering maturity (M) and project performance (Y). The novelty of this study lies in translating these constructs into 20 measurement items and conducting an initial empirical assessment through validity testing, reliability testing, and descriptive statistical analysis using responses from 50 respondents. This assessment provides an initial basis for further investigation, rather than conclusive evidence of the relationships among the proposed constructs.

Based on these conditions, this study analyzes partnering depth through three main groups of factors, namely relationship factors (X1), process factors (X2), and environmental factors (X3). Relationship factors include trust, communication, commitment, openness, and goal alignment. Process factors include coordination, risk sharing, quality control, problem solving, decision making, and stakeholder involvement. Meanwhile, environmental factors include management support, organizational culture, contract conditions, regulations, and project characteristics. The classification of these factors refers to the framework used in previous research on contractor–designer partnering in Design and Build projects [2], [10].

In addition to relationship, process, and environmental factors, this study uses partnering maturity (M) as a mediating variable that describes the development of partnering

relationships from transactional to coordinative, collaborative, integrative, and strategic levels. This concept is consistent with research on partnering maturity in Indonesian construction projects, which developed indicators for measuring the development of partnering maturity throughout the project life cycle [11].

Empirically, this study employs a quantitative approach involving 50 respondents representing designers, contractors, and owners involved in government projects using the Design and Build scheme. Purposive sampling was employed, while the research instruments were evaluated using validity testing, reliability testing, and descriptive statistical analysis using SPSS. This empirical approach and respondent groups follow the research design applied in the study of contractor–designer partnering in Design and Build projects [2].

The initial analysis indicates that the process factor (X2) has a standard deviation of 2.01. This factor is associated with coordination, risk sharing, quality control, problem solving, decision making, and stakeholder involvement in the working relationship between designers and contractors. These findings provide a basis for examining how partnering factors can be used to measure the depth of relationships in government projects using the Design and Build scheme.

Based on the foregoing discussion, the primary objective of this study is to develop and conduct an initial empirical assessment of a quantitative measurement framework for describing the depth of partnering between designers and contractors in government Design and Build projects. The proposed framework organizes partnering depth into three dimensions: relationship factors (X1), process factors (X2), and environmental factors (X3), while also incorporating partnering maturity (M) and project performance (Y) as related constructs. The framework is intended to provide a structured means of assessing these dimensions and describing the characteristics of partnering relationships in the context of government Design and Build projects.

In practical terms, the framework can help government project owners, designers, and contractors identify partnering dimensions that require closer attention and provide a structured basis for discussing improvements in coordination and integration between design and construction. Given the scope of the present analysis, the framework should be regarded as an initial assessment aid rather than a fully validated tool for predicting project performance.

In this study, the empirical assessment focuses on the validity and reliability of the measurement items and the descriptive characteristics of the responses. Accordingly, the findings provide an initial assessment of the proposed measurement framework and do not establish causal relationships or confirm the mediating role of partnering maturity.

METHOD

This study employed a quantitative approach through data collection from respondents, which was subsequently analyzed using IBM SPSS Statistics. The respondents were selected using a purposive sampling technique based on their relevant experience and professional positions in construction projects. Practitioner respondents were selected from relevant project positions, while academic respondents were required to hold at least a Master's degree.

The study involved 50 respondents selected through purposive sampling based on their professional roles and relevant experience in construction projects. This sample was used to obtain initial empirical evidence for assessing the measurement instrument, particularly through item validity testing, internal consistency assessment, and descriptive statistical analysis. The number of respondents should therefore be interpreted in relation to the preliminary measurement-assessment scope of this study, rather than as evidence of population-wide representativeness or as a basis for confirming complex causal or mediation relationships. Respondent characteristics were further examined in terms of job level, work experience, and job role to provide context for interpreting the survey results.

The respondent profiles were examined based on job level, work experience, and job role. The distribution of respondents based on job level is presented in Figure 1. The largest proportion of respondents were Project Managers, accounting for 39% of the total respondents.

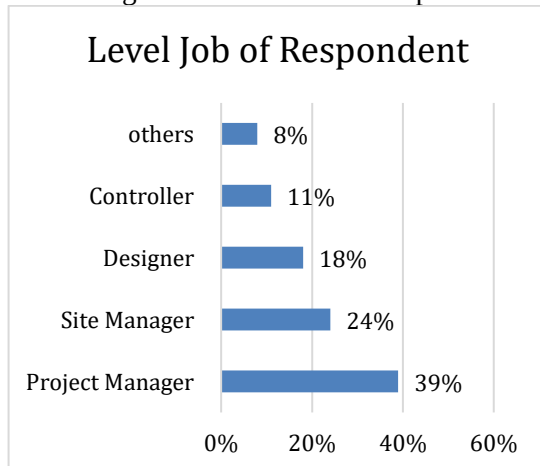


Figure 1. Job Level of Respondents

The distribution of respondents based on work experience is presented in Figure 2. The respondents had varying levels of project experience, with the largest proportion having 10–15 years of experience.

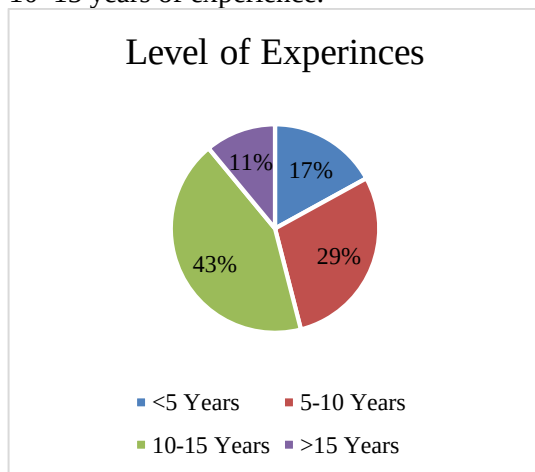


Figure 2. Level of Experiences Respondent

Furthermore, the distribution of respondents based on job role is presented in Figure 3. The largest proportion of respondents came from the contractor group.

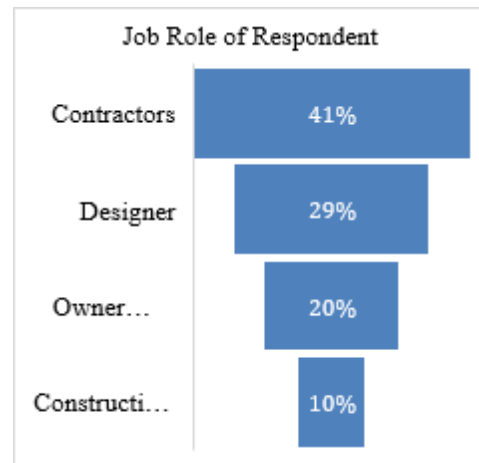


Figure 3. Job Role of Respondents

The variables used in this study were defined and grouped into five main constructs, as follows:

1. Relationship Factor (X1): consists of trust, effective communication, and mutual commitment.
2. Process Factor (X2): includes early involvement, risk sharing, work mechanisms, coordination, and quality control.
3. Environmental Factor (X3): covers regulations and policies, technological support, and construction market conditions.
4. Partnering Maturity (M): reflects the partnership organizational structure, agreement formality, and strategic alignment among the parties.
5. Project Performance (Y): is measured through indicators of time, cost, quality, occupational health and safety (OHS), environment, and client satisfaction.

Based on these constructs, the operational research model is presented in Figure 4.

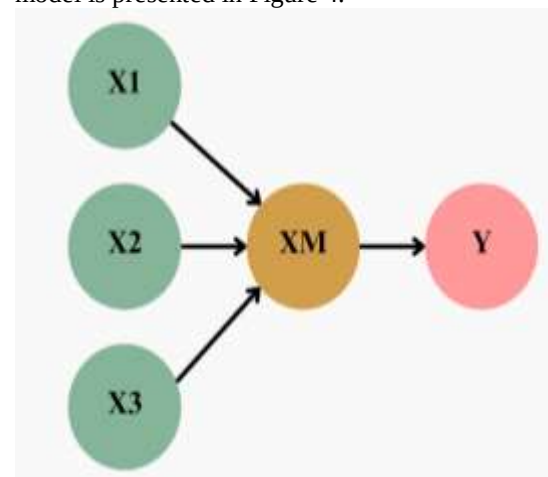


Figure 4. Operational Research Model

Figure 4 illustrates the operational research model, in which the Relationship Factor (X1), Process Factor (X2), Environmental Factor (X3), and

Partnering Maturity (M) are examined in relation to Project Performance (Y).

Table 1. Operational Variables of X1 (Relationship Factor)

Code	Indicator	Operational Definition	Source
X1.1	Trust	The level of confidence among parties that each party performs its role appropriately and does not harm other parties.	[12]
X1.2	Effective Communication	The level of effectiveness and continuity of technical and administrative communication throughout the design–construction process.	[12]
X1.3	Mutual Commitment	The willingness of the parties to work collaboratively to achieve the objectives of the Design and Build (DB) project.	[13]

Table 2. Operational Variables of X2 (Process Factor)

Code	Indicator	Operational Definition	Source
X2.1	Early Involvement	The involvement of designers and contractors from the early planning stage.	[14]
X2.2	Risk Sharing	Risk sharing among the owner, designer, and contractor is conducted fairly and transparently.	[15]
X2.3	Work Mechanism	The clarity of an integrated design–construction workflow.	[16]
X2.4	Coordination	The effectiveness of cross-functional coordination throughout the Design and Build process.	[17]
X2.5	Quality Control	The process of comprehensively monitoring design and construction quality.	[18]

Table 3. Operational Variables of X3 (Environmental Factor)

Code	Indicator	Operational Definition	Source
X3.1	Regulations and Policies	The influence of regulations, permits, and government policies on the implementation of Design and Build projects.	[19]
X3.2	Technology Support	The utilization of BIM, digital platforms, and project information systems.	[20]

X3.3	Market Conditions	The availability of materials and labor, as well as construction market price dynamics.	[21]
-------------	-------------------	---	------

Table 4. Operational Variables of M (Partnering Maturity)

Code	Indicator	Operational Definition	Source
M1	Partnership Organizational Structure	The clarity of the organizational structure, roles, and responsibilities among the parties.	[22]
M2	Agreement Formality	The level of clarity and formality of agreements, memoranda of understanding (MoUs), and Design and Build contracts.	[23]
M3	Strategic Alignment	The level of alignment of goals, priorities, and expectations among the parties.	[24]

Table 5. Operational Variables of Y (Project Performance)

Code	Indicator	Operational Definition	Source
Y1	Time	The level of project completion accuracy against the baseline schedule.	[25]
Y2	Cost	The deviation of construction	[26]

		costs from the budget.	
Y3	Quality	The level of achievement of construction quality standards.	[27]
Y4	Occupational Health and Safety (OHS)	The achievement of occupational safety and health standards.	[28]
Y5	Environment	Compliance with environmental standards and impact management.	[29]
Y6	Client Satisfaction	The perception and level of satisfaction of the project owner.	[30]

The quantitative data analysis consisted of two stages:

1. Validity Test

The validity test was conducted to assess the extent to which each statement item adequately represents the construct being measured. Instrument validity was examined using the Corrected Item–Total Correlation method with the assistance of IBM SPSS Statistics. An item was considered valid when its correlation value was greater than or equal to the critical r-value at a 5% significance level. The validity testing procedure was based on the following criteria:

- Pearson Product–Moment Correlation r calculated $\geq r$ table.
- An item was considered valid if
- With a total of 50 respondents and a significance level of 5% ($\alpha = 0.05$), the r-table value was 0.279, which was used as the basis for determining item validity.

2. Reliability Test

The reliability of the research instrument was evaluated using the Cronbach's Alpha

coefficient. The instrument was considered to have good reliability when the Cronbach's Alpha value was ≥ 0.70 , following the criterion proposed by Nunnally and Bernstein (1994).

RESULTS AND DISCUSSION

1. Validity Test Results

The validity test was conducted on 50 respondents to ensure that the research instrument appropriately measured the constructs under investigation. The results of the instrument validity test are presented in Table 6.

Table 6. Results of the Instrument Validity Test (n = 50)

Variable	Item	r calculated	r table	Remark
X1 – Relationship Factor	X1.1	0.523	0.279	Valid
	X1.2	0.601	0.279	Valid
	X1.3	0.744	0.279	Valid
X2 – Process Factor	X2.1	0.498	0.279	Valid
	X2.2	0.672	0.279	Valid
	X2.3	0.589	0.279	Valid
	X2.4	0.731	0.279	Valid
	X2.5	0.614	0.279	Valid
X3 – Environmental Factor	X3.1	0.556	0.279	Valid
	X3.2	0.684	0.279	Valid
	X3.3	0.747	0.279	Valid
M – Partnering Maturity	M1	0.612	0.279	Valid
	M2	0.701	0.279	Valid
	M3	0.778	0.279	Valid
Y – Project Performance	Y1	0.545	0.279	Valid
	Y2	0.683	0.279	Valid
	Y3	0.721	0.279	Valid
	Y4	0.602	0.279	Valid
	Y5	0.744	0.279	Valid

Y6	0.811	0.279	Valid
----	-------	-------	-------

Based on the validity test results for the 20 statement items covering the Relationship Factor (X1), Process Factor (X2), Environmental Factor (X3), Partnering Maturity (M), and Project Performance (Y), all r calculated values were greater than the r table value of 0.279 at the 5% significance level. The r calculated values ranged from 0.498 to 0.811. These results indicate that all statement items met the established validity criterion and were considered valid for measuring their respective constructs. Therefore, no item was eliminated from the research instrument.

2. Reliability Test Results

The reliability test was conducted to evaluate the internal consistency of the research instrument. The reliability results for the five research variables, consisting of X1 (Relationship Factor), X2 (Process Factor), X3 (Environmental Factor), M (Partnering Maturity), and Y (Project Performance), are presented in Table 7.

Table 7. Results of the Instrument Reliability Test

Variable	Number of Items	Cronbach's Alpha	Remark
X1 – Relationship Factor	3	0.812	Reliable
X2 – Process Factor	5	0.876	Reliable
X3 – Environmental Factor	3	0.841	Reliable
M – Partnering Maturity	3	0.884	Reliable
Y – Project Performance	6	0.903	Reliable

All research variables obtained Cronbach's Alpha values above the minimum threshold of 0.70. The values ranged from 0.812 for the Relationship Factor (X1) to 0.903 for Project Performance (Y). These results indicate that all research variables demonstrated good internal consistency and met the reliability criterion established in this study.

3. Instrument Feasibility

Based on the validity and reliability test results, all 20 statement items obtained r calculated values greater than r table (0.279), indicating that all items met the validity requirements. In addition, all variables obtained Cronbach's Alpha values ≥ 0.70 , indicating adequate internal consistency of the research instrument.

Therefore, all items and constructs met the validity and reliability criteria and were retained for subsequent analysis. A comparison of the Cronbach's Alpha values for each research variable is presented visually in Figure 6.



Figure 6. Comparison of Cronbach's Alpha Values

Figure 6 presents a bar chart of the Cronbach's Alpha values for each research variable. The dashed line represents the minimum reliability threshold of 0.70. As shown in the visualization, all variables have reliability values above this threshold, ranging from 0.812 to 0.903.

The results indicate that none of the research variables failed to meet the established reliability criterion. The Cronbach's Alpha values for X2, M, and Y are above 0.85, indicating a high level of internal consistency. Overall, the variation in Cronbach's Alpha

values across the variables remains within the acceptable reliability range, indicating strong internal consistency of the research instrument.

Descriptive statistics for all research variables based on the results of the limited questionnaire test are presented in Table 8.

Table 8. Descriptive Statistics of the Research Variables (n = 50)

Variable	Mean	Std Dev.	Minimum	Maximum
X1 – Relationship Factor	12.17	1.61	9	15
X2 – Process Factor	21.18	2.01	14	24
X3 – Environmental Factor	12.61	1.37	9	14
M – Partnering Maturity	11.27	1.63	8	14
Y – Project Performance	23.91	2.44	19	29

Based on Table 8, all research variables show relatively high mean values with moderate data dispersion. Project Performance (Y) has the highest mean value of 23.91, with a standard deviation of 2.44. This result indicates that respondents provided relatively high assessments of the Project Performance indicators in Design and Build projects, covering time, cost, quality, occupational health and safety, environmental performance, and client satisfaction.

The Process Factor (X2) has a mean value of 21.18 and a standard deviation of 2.01. This result indicates that respondents provided relatively positive assessments of project

process aspects, including coordination among parties, risk sharing, quality control, and stakeholder involvement during project implementation. The Environmental Factor (X3) has a mean value of 12.61 and a standard deviation of 1.37. This finding indicates that project environmental aspects, including regulations, technological support, and external project conditions, were perceived relatively positively by the respondents, with relatively low variation in responses.

The Relationship Factor (X1) has a mean value of 12.17 and a standard deviation of 1.61. This value indicates that respondents perceived the relationships among project parties, including trust, communication, and mutual commitment, as relatively positive in the implementation of Design and Build projects. Partnering Maturity (M) has a mean value of 11.27 and a standard deviation of 1.63. This result indicates that the maturity of partnering relationships among project participants had been established relatively well based on the respondents' perceptions during the instrument testing stage.

The standard deviations of all variables are relatively smaller than their respective mean values. This indicates that the respondents' responses tended to be relatively homogeneous, with no large variation in the data at the limited questionnaire testing stage. These descriptive results provide an initial overview of the characteristics of the research data and complement the validity and reliability test results presented previously.

CONCLUSION

This study developed a quantitative measurement framework to examine partnering factors and project performance in government Design and Build projects. The research operationalized five main constructs, namely the Relationship Factor (X1), Process Factor (X2), Environmental Factor (X3), Partnering Maturity (M), and Project Performance (Y), which were represented by 20 measurement items.

The instrument testing involving 50 respondents showed that all 20 measurement items met the validity criterion. The r

calculated values ranged from 0.498 to 0.811 and were higher than the r table value of 0.279. The reliability test also showed that all constructs met the established criterion, with Cronbach's Alpha values ranging from 0.812 to 0.903. These results indicate that the measurement items demonstrated adequate validity and internal consistency.

The descriptive analysis showed mean values of 12.17 for X1, 21.18 for X2, 12.61 for X3, 11.27 for M, and 23.91 for Y. The findings provide an initial description of respondents' perceptions regarding relationship, process, environmental factors, partnering maturity, and project performance in Design and Build projects.

Overall, the instrument developed in this study provides a valid and reliable basis for further quantitative analysis of partnering and project performance. Further research is required to examine the relationships among the proposed constructs and to investigate the role of partnering maturity in government Design and Build project performance.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to all respondents who participated in this study and provided the data required for the research. The authors also acknowledge the contributions of all parties who supported the data collection and implementation of this research.

BIBLIOGRAPHY

- [1] N. K. Armaeni, I. W. G. E. Triswandana, and I. P. A. Sanjaya, "Identifying Inhibiting and Enabling Factors for Design-Build Method Adoption in Local Government Projects in Indonesia," *ASTONJADRO*, vol. 14, no. 2, pp. 422–429, May 2025, doi: 10.32832/astonjadro.v14i2.17244.
- [2] A. Sutowo, A. P. Irawan, E. Murtiana Sari, and O. Fuk Jin, "Faktor Yang Memengaruhi Kemitraan Kontraktor Dan Perancang Dalam Proyek Design and Build," *J. Tek. Sipil Cendekia*, vol.

- 7, no. 1, pp. 1–14, 2026, doi: 10.51988/jtsc.v7i1.413.
- [3] E. M. Sari, A. P. Irawan, M. A. Wibowo, J. P. Siregar, and A. K. A. Praja, “Project Delivery Systems: The Partnering Concept in Integrated and Non-Integrated Construction Projects,” *Sustain.*, vol. 15, no. 1, 2023, doi: 10.3390/su15010086.
- [4] G. Ying, Y. Menghu, G. Yihong, and Z. Shuibo, “How to Build Interorganizational Trust in Construction Projects: A Meta-Analysis on Three Trust-Building Mechanisms,” *J. Manag. Eng.*, vol. 41, no. 4, p. 4025024, Jul. 2025, doi: 10.1061/JMENEAE.0000000.
- [5] D. S. Mentari and A. S. Mutaqi, “Faktor Komunikasi dan Kolaborasi dalam Integrated Project Delivery,” *J. Rekayasa Konstr. Mek. Sipil*, vol. 7, no. 1, pp. 31–37, 2024, doi: 10.54367/jrkms.v7i1.3165.
- [6] M. A. W. , D. M. , E. M. S. Antho Thohirin, “Kebijakan Pengukuran Kedalaman Partnering untuk Meningkatkan Kinerja Proyek Konstruksi,” *J. Ilm. Ilmu Adm.* Vol. 7 , No. 2, Desember 2024, pp. 239-252 , vol. 7, no. 2, pp. 239–252, 2024, doi: DOI: 10.31334/transparansi/v7i1.4276.
- [7] E. M. Sari *et al.*, “Challenge and awareness for implemented integrated project delivery (IPD) in Indonesian projects,” *Buildings*, vol. 13, no. 1, p. 262, 2023.
- [8] M. M. Iqbal and A. Susanto, “Peran Stakeholder pada Proyek Konstruksi yang Berbasis Integrated Project Delivery (IPD),” *J. Rekayasa Konstr. Mek. Sipil*, vol. 8, no. 1, pp. 87–93, 2025, doi: 10.54367/jrkms.v8i1.4280.
- [9] M. Bresnen, S. J. Lennie, and N. Marshall, “Partnering in construction re-visited: gauging progress in industry practice and prospects for advances in academic research,” *Constr. Manag. Econ.*, vol. 43, no. 1, pp. 59–77, 2025, doi: 10.1080/01446193.2024.2416035.
- [10] L. E. Bygballe and A. Swärd, “Collaborative Project Delivery Models and the Role of Routines in Institutionalizing Partnering,” *Proj. Manag. J.*, vol. 50, no. 2, pp. 161–176, Apr. 2019, doi: 10.1177/8756972818820213.
- [11] A. Thohirin, M. A. Wibowo, D. Mohamad, E. M. Sari, R. Z. Tamin, and H. Sulistio, “Tools and Techniques for Improving Maturity Partnering in Indonesian Construction Projects,” *Buildings*, vol. 14, no. 6, p. 1494, May 2024, doi: 10.3390/buildings14061494.
- [12] S. Moradi and K. Kähkönen, “Success in collaborative construction through the lens of project delivery elements,” *Built Environ. Proj. Asset Manag.*, vol. 12, no. 6, pp. 973–991, 2022, doi: 10.1108/BEPAM-09-2021-0118.
- [13] N. Shin, J. S. Yoo, and I. W. G. Kwon, “Fostering trust and commitment in complex project networks through dedicated investment in partnership management,” *Sustain.*, vol. 12, no. 24, pp. 1–21, 2020, doi: 10.3390/su122410397.
- [14] P. A. Wondimu, O. J. Klakegg, and O. Lædre, “Early contractor involvement (ECI): ways to do it in public projects,” *J. Public Procure.*, vol. 20, no. 1, pp. 62–87, 2020, doi: 10.1108/JOPP-03-2019-0015.
- [15] S. Ali, A. Odey, and H. Ola, “Risk Assessment Model for Optimal Gain–Pain Share Ratio in Target Cost Contract for Construction Projects,” *J. Constr. Eng. Manag.*, vol. 148, no. 2, p. 4021197, Feb. 2022, doi: 10.1061/(ASCE)CO.1943-7862.0002222.
- [16] M. Sheikhhoshkar, H. Bril El-Haouzi, A. Aubry, F. Hamzeh, and F. Rahimian, “From process-based to technology-driven: a study on functionalities as key elements of collaborative planning methods for construction projects,” *Prod. Plan. Control*, vol. 36, no. 10, pp. 1330–1351, 2025, doi: 10.1080/09537287.2024.2360581.

- [17] M. Ohag, A. H. Nawawi, F. Muhammad, and N. Hashim, "Critical Coordination Factors Affecting Design and Build Projects," *Int. J. Environ. Archit. Soc.*, vol. 3, no. 01, pp. 59–71, 2023, doi: 10.26418/ijeas.2023.3.01.59-71.
- [18] N. P. H. D. and T. Daniel, "Exploring the Use of Quality Control Plans for Alternative Contracting Methods in Highway Projects," *J. Constr. Eng. Manag.*, vol. 150, no. 5, p. 4024030, May 2024, doi: 10.1061/JCEMD4.COENG-14123.
- [19] P. H. D. Nguyen, D. Tran, S. Scott, and L. Konrath, "Implementation of Progressive Design-Build in Airport Capital Construction Projects," *Transp. Res. Rec.*, vol. 2678, no. 12, pp. 1098–1109, 2024, doi: 10.1177/03611981241249743.
- [20] L. Liao, E. A. L. Teo, and R. Chang, "Reducing critical hindrances to building information modeling implementation: The case of the Singapore construction industry," *Appl. Sci.*, vol. 9, no. 18, 2019, doi: 10.3390/app9183833.
- [21] S. Melaku Belay, S. Tilahun, M. Yehualaw, J. Matos, H. Sousa, and E. T. Workneh, "Analysis of Cost Overrun and Schedule Delays of Infrastructure Projects in Low Income Economies: Case Studies in Ethiopia," *Adv. Civ. Eng.*, vol. 2021, no. 1, Jan. 2021, doi: 10.1155/2021/4991204.
- [22] W. Shen, W. Tang, Y. Wang, C. F. Duffield, F. K. P. Hui, and L. Zhang, "Managing Interfaces in Large-Scale Projects: The Roles of Formal Governance and Partnering," *J. Constr. Eng. Manag.*, vol. 147, no. 7, Jul. 2021, doi: 10.1061/(ASCE)CO.1943-7862.0002101.
- [23] Y. Luo and Y. Chen, "How does contractual governance affect construction project performance? The mediating role of the contractor's behavior," *J. Asian Archit. Build. Eng.*, vol. 24, no. 5, pp. 3879–3897, 2025, doi: 10.1080/13467581.2024.2396606.
- [24] A. P. Haniff and L. Galloway, "Modeling strategic alignment in project networks," *Int. J. Proj. Manag.*, vol. 40, no. 5, pp. 517–530, 2022, doi: 10.1016/j.ijproman.2022.05.001.
- [25] P. V. Ingle and G. Mahesh, "Construction project performance areas for Indian construction projects," *Int. J. Constr. Manag.*, vol. 22, no. 8, pp. 1443–1454, 2022, doi: 10.1080/15623599.2020.1721177.
- [26] L. Yunping, A. Baabak, and S. Wei, "Analysis of the Variability of Project Cost and Schedule Performance in the Design-Build Environment," *J. Constr. Eng. Manag.*, vol. 146, no. 6, p. 4020060, Jun. 2020, doi: 10.1061/(ASCE)CO.1943-7862.0001851.
- [27] S. Nyakala, J. Pretorius, and A. Vermeulen, "Construction quality process implementation as a source of competitive advantage in small and medium-sized construction projects," *J. Constr. Bus. Manag.*, vol. 4, no. 2, pp. 46–54, 2021, doi: 10.15641/jcbm.4.2.862.
- [28] International Organization for Standardization, "ISO 45001:2018 Occupational Health and Safety Management Systems --- Requirements with Guidance for Use," 2018, *International Organization for Standardization, Geneva, Switzerland*.
- [29] M. Alnsour, A. Zeidan, B. Al Quwaider, A. Alkubaisi, R. Alregeb, and M. Bader, "Developing sustainability assessment indicators for measuring contractor's performance during the construction phase of construction projects in Jordan," *Asian J. Civ. Eng.*, vol. 24, no. 1, pp. 245–266, 2023, doi: 10.1007/s42107-022-00500-5.
- [30] E. Asadian, R. Leicht, R. Cheng, and C. Neuhauser, "Project Owner Satisfaction Forecasting through Longitudinal Monitoring of Project Team Attributes," *Eng. Proj. Organ. J.*, vol. 11, 2022.