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Determining Solutions to Supply Chain Disruptions in Construction Projects: A Case Study of the Physical Construction of Padat Karya Flats Phase II

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ABSTRACT

Supply chain disruptions pose significant challenges to construction projects by delaying material procurement, increasing costs, and adversely affecting project performance. However, limited research has systematically identified and prioritized effective mitigation strategies. This study aimed to identify the internal and external factors contributing to supply chain disruptions and determine priority solutions and adaptive strategies for contractors involved in the Phase II Construction Project of the Padat Karya Flats in the Special Capital Region of Jakarta (Daerah Khusus Ibukota Jakarta, DKI Jakarta), Indonesia. A mixed-methods case study approach integrating qualitative and quantitative analyses was employed. Data were obtained from project procurement records, monthly progress reports, and meeting minutes covering January to June 2026. The data were analyzed using Pareto analysis, focus group discussions (FGDs), the Analytic Hierarchy Process (AHP), strengths, weaknesses, opportunities, and threats (SWOT) analysis, Cartesian quadrant analysis, and stakeholder mapping. The findings identified geopolitical factors (21.62%), exchange rate fluctuations (20.27%), increases in raw material prices (17.57%), material shortages (9.46%), and financial disruptions (8.11%) as the primary causes of supply chain disruptions. The AHP results identified procurement strategy as the highest-priority criterion (41.62%), while integrated procurement systems (32%) and procurement diversification (31%) emerged as the leading strategic alternatives. The SWOT analysis identified procurement diversification as the preferred strategy, with a total score of 3.82 and a position in Quadrant I, indicating favorable conditions for implementing a proactive strategy. These findings suggest that supplier diversification, supported by integrated procurement systems and strengthened internal procurement policies, could enhance supply chain resilience, minimize procurement risks, and improve contractor adaptability to disruptions in construction projects.

INTRODUCTION

The construction industry is a strategic sector in Indonesia's national development and a major contributor to economic growth. Extensive infrastructure development, including roads, bridges, dams, residential housing, and other public facilities, has contributed to economic expansion and more equitable regional development (Biemo & Soemardi, 2024).

The Indonesian government has continued to accelerate infrastructure development through various initiatives, including National Strategic Projects (Proyek Strategis Nasional, PSN), the People's School (Sekolah Rakyat) program, industrial estate development, housing construction, and the development of Indonesia's new capital city, Nusantara (Ibu Kota Nusantara, IKN). These initiatives have contributed to increased employment in the construction sector, as reflected in the permanent construction worker index, which rose from 111.94 in the fourth quarter of 2024 to 113.08 in the fourth quarter of 2025 (Table 1). Consistent with this trend, Statistics Indonesia (Badan Pusat Statistik, BPS) reported that the construction sector maintained strong performance in 2025, contributing 10.16% to Indonesia's gross domestic product (GDP) in the fourth quarter of 2025 (Konstruksi & Indicators, 2026).

Table 1. Index (2016=100) and Quarter-to-Quarter Growth of Permanent Construction Workers, Q4/2024–Q4/2025

Quarter	Index	Growth (%)
Q4-2024	111.94	0.68
Q1-2025	109.90	-1.82
Q2-2025	110.93	0.93
Q3-2025	112.23	1.17
Q4-2025	113.08	0.75

Source: Konstruksi & Indicators (2026)

Despite its substantial contribution to national economic development, the construction sector continues to face numerous challenges that may hinder its growth and operational performance. These challenges include supply chain disruptions, price fluctuations, adverse weather conditions, resource limitations, inadequate project planning, slow adoption of emerging technologies, shortages of skilled labor, complex regulatory requirements, and economic uncertainty. (Asnudin, 2023) reported that the COVID-19 pandemic caused widespread disruptions to construction supply chains, workforce and equipment mobilization, and working schedules, resulting in liquidity constraints that forced some contractors to liquidate assets to maintain business operations. (Amalia et al., 2023) investigated potential supply chain disruptions in a road construction project in Grobogan Regency and identified technical errors and miscommunication between contractors and suppliers as major obstacles contributing to substantial financial losses. Similarly, (Bian et al., 2020) identified several primary causes of delays in precast concrete slab procurement, including production equipment failures, unsuccessful deliveries caused by restricted site access, and government regulations limiting the operating hours of heavy vehicles. (Nyaribo & Muturi, 2017) reported that project success was influenced by project planning (22%), supply chain and contract management (22%), communication and coordination (22%), risk management (16%), and cost control (18%). Their findings also indicated that material procurement accounted for approximately 30%–40% of total project value, highlighting the importance of effective supply chain management in construction project performance.

Supply chain disruptions involve unexpected events that interrupt the normal flow of materials, information, or products, thereby adversely affecting project operations and performance (Craighead et al., 2007). Global disruptions, including pandemics, geopolitical

conflicts, and international economic sanctions, can lead to delivery delays, rising material prices, and increased uncertainty in supply and demand (Ivanov, 2020). In the construction industry, these disruptions are particularly challenging because projects are typically unique, time-sensitive, and dependent on coordination among multiple stakeholders. Consequently, supply chain disruptions can directly affect project schedules, costs, material availability, and the achievement of performance targets, increasing the likelihood of project delays and failure (Dolgui et al., 2021). Economic sanctions further complicate supply chain operations by restricting international trade, investment, and financial transactions (Hufbauer et al., 2007). Such restrictions may limit the importation of construction materials, discourage foreign investment, and intensify exchange rate volatility (J., 2019). Companies with substantial dependence on international supply networks are particularly vulnerable to these disruptions because of their exposure to global economic and geopolitical uncertainties (Baldwin & Freeman, 2022).

Organizational resilience plays a critical role in mitigating the adverse effects of supply chain disruptions. It encompasses an organization's capacity to anticipate, absorb, respond to, adapt to, and recover from internal and external disturbances while maintaining essential operational functions. Duchek, (2020) conceptualized organizational resilience through three interconnected dimensions: anticipation, coping, and adaptation. In construction projects, organizational resilience can be reflected in resource flexibility, material substitution capabilities, supplier diversification, and organizational learning. Effective project performance therefore depends substantially on an organization's ability to manage complexity, uncertainty, and operational risks (Kumar et al., 2023). A resilient supply chain enables organizations to maintain operational continuity during crises and minimize the consequences of unexpected disruptions (Ponomarov & Holcomb, 2009). Moreover, supply chain resilience extends beyond restoring previous operational conditions to include the capacity for adaptation, transformation, and continuous improvement (Wieland & Durach, 2021). Adaptive strategies further strengthen organizational resilience by enabling companies to dynamically adjust their strategic priorities, resources, and operational processes through environmental sensing, strategic flexibility, resource reconfiguration, and organizational learning (Cozzolino & Verona, 2024). Construction activities encompass the construction, operation, maintenance, demolition, and reconstruction of buildings and infrastructure (Indonesia, 2017). These activities are governed by interrelated constraints involving cost, quality, and time and require effective coordination of human resources, materials, equipment, construction methods, financial resources, information, and technology (Mitra & Sipil, 2018). Construction projects also involve multiple engineering disciplines, including industrial, mechanical, electrical, and geotechnical engineering, which increase their organizational and technical complexity (Iii, 2009). Accordingly, construction project performance is commonly evaluated through schedule performance (Kerzner, 2022), cost performance (Flyvbjerg, 2014), quality compliance (Juran, 2010), occupational safety (Hinze, 2013), and stakeholder satisfaction (Atkinson, 1999).

Several analytical and decision-support methods can be applied to identify, prioritize, and formulate strategies for mitigating construction supply chain disruptions. Pareto analysis facilitates the prioritization of problems by ranking their frequency or impact, often drawing

on the 80/20 principle, which suggests that a relatively small proportion of causes may account for a substantial proportion of observed problems (Suherman & Cahyana, 2019). This approach has been applied to identify the primary causes of procurement delays in construction projects (Arif & Gunawan, 2023). Focus group discussions (FGDs) provide a qualitative approach for gathering stakeholder perceptions, experiences, and collective judgments regarding operational challenges and potential solutions (Pradipta et al., 2024). The Analytic Hierarchy Process (AHP), developed by Thomas L. Saaty, is a multicriteria decision-making method that structures complex problems hierarchically and assigns relative priority weights to evaluation criteria and strategic alternatives (Muanley et al., 2022). Previous research has applied AHP to prioritize factors contributing to supply chain delays (Hendi Kurniawan, 2020), using procedures that include developing a decision hierarchy, conducting pairwise comparisons, calculating priority weights, and evaluating judgment consistency (Wiwik Handayani, 2022). Strengths, weaknesses, opportunities, and threats (SWOT) analysis provides a framework for assessing internal organizational conditions and external environmental factors to formulate strength–opportunity (SO), weakness–opportunity (WO), strength–threat (ST), and weakness–threat (WT) strategies (Safitri et al., 2024; Amalia et al., 2022). Furthermore, Cartesian quadrant analysis supports strategic positioning by calculating the difference between strengths and weaknesses on the horizontal axis (X = Strengths − Weaknesses) and between opportunities and threats on the vertical axis (Y = Opportunities − Threats) (Larasati, 2025; Ariwibowo, 2025). Stakeholder mapping complements these approaches by classifying stakeholders according to their relative power and interest into four categories: manage closely, keep satisfied, keep informed, and monitor with minimal effort (Zhu et al., 2024). The indicators identified from the relevant literature and used to support the analysis of construction supply chain disruptions are summarized in Table 2.

Table 2. Initial Research Indicators Derived from the Literature

Variable	Indicator	Reference
Supply chain disruption	Material price increase (X1)	Ivanov (2020)
	Production disruption (X2)	Craighead et al. (2007)
	Exchange rate fluctuation (X3)	Hufbauer et al. (2007)
	Material delay (X4)	Dolgui et al. (2021)
	Material scarcity (X5)	Dolgui et al. (2021)
Contractor resilience	Risk anticipation (R1)	Duchek (2020)
	Resource flexibility (R2)	Ponomarov & Holcomb (2009)
	Supplier diversification (R3)	Cozzolino & Verona (2024)
	Adaptation/recovery capability (R4)	Ponomarov & Holcomb (2009)
	Organizational learning (R5)	Ponomarov & Holcomb (2009)
Adaptive strategy	Material substitution (S1)	Cozzolino & Verona (2024)
	Supplier diversification (S2)	Kerzner (2022)
	Project schedule adjustment (S3)	Cozzolino & Verona (2024)
	Supply chain digitalization (S4)	Cozzolino & Verona (2024)
	Stakeholder collaboration (S5)	Cozzolino & Verona (2024)
Project performance	Timeliness (P1)	Kerzner (2022)
	Cost accuracy (P2)	Flyvbjerg (2014); Kerzner (2022)
	Work quality (P3)	Flyvbjerg (2014)
	Productivity (P4)	Flyvbjerg (2014)
	Work safety (P5)	–

Source: Data processing (2026)

Although supply chain disruptions significantly affect on-site construction activities, relatively few studies have systematically integrated strategic formulation and decision-making methods to address these challenges. Previous research has primarily focused on macroeconomic perspectives, pandemic-related disruptions, and conceptual assessments of supply chain resilience, with limited attention to developing actionable adaptive strategies for building construction projects in Indonesia (Ivanov, 2020; Kumar et al., 2023; Baldwin & Freeman, 2022). To address this research gap, the novelty of the present study lies in its integrated multicriteria decision-making framework, which combines the identification of supply chain disruption factors through literature review, Pareto analysis, and focus group discussions (FGDs); the formulation of alternative mitigation strategies through strengths, weaknesses, opportunities, and threats (SWOT) analysis; and the prioritization of strategic alternatives using the Analytic Hierarchy Process (AHP), complemented by Cartesian quadrant analysis and stakeholder mapping. Accordingly, this study aims to identify the internal and external factors contributing to supply chain disruptions, examine their impacts on construction project performance, and determine priority mitigation measures and adaptive strategies for contractors involved in the Phase II Construction Project of the Padat Karya Flats.

METHOD

This study employed a descriptive case study design integrating qualitative and quantitative approaches, consistent with established reporting standards for qualitative and mixed-methods research (Levitt et al., 2018). The qualitative approach was used to identify supply chain disruptions, their underlying causes, and potential adaptive strategies through a literature review, in-depth interviews, and focus group discussions (FGDs). The quantitative approach was used to assess and prioritize disruption factors and strategic alternatives through weighting, scoring, and simulation. The research focused on the Phase II Construction Project of the Padat Karya Flats (Rumah Susun Padat Karya) in Jakarta, Indonesia, which was implemented in 2026 under the supervision of the Jakarta Provincial Public Housing and Settlement Areas Agency (Dinas Perumahan Rakyat dan Kawasan Permukiman, DPRKP). The project was selected because it had experienced supply chain disruptions and involved multiple stakeholders, including government agencies, contractors, consultants, and material suppliers. The scope of the study was limited to supply chain disruptions and their impacts on project implementation.

The study used primary and secondary data (Suwarsa, 2021). Primary data were collected through FGDs, interviews, questionnaires, and field observations involving stakeholders directly engaged in project procurement and implementation. Secondary data included procurement records, monthly progress reports, financial reports, the project cost estimate (Rencana Anggaran Biaya, RAB), and meeting minutes from January to June 2026, along with relevant previous studies. The research variables and indicators are presented in Table 3.

Table 3. Main Research Variables

Variable	Definition	Aspect	Instrument	Data Source
Strategy/solution	Formulation of future steps to build a vision and mission focused on long-term goals and how they will be achieved (Artana et al., 2011)	Profit/loss	Monthly project report; cost estimate to completion	Secondary
		Project cost	Current project cost estimate (RAB); contract change order (CCO) report	Secondary
Supply chain disruption	Condition in which the flow of goods and materials is obstructed, disrupted, or interrupted, causing delays, higher costs, and lower operational performance	Procurement process	Procurement request report; administrative completeness	Secondary
		Distribution process	Material receipt report	Secondary
		Government policy	Procurement constraint report	Secondary
			Procurement minutes of meeting (MOM)	Primary

Source: Data processing (2026)

The research was conducted in five stages, as summarized in Table 4 (Syahputri et al., 2023). Focus group discussions (FGDs) involved senior management representatives, supply chain management (SCM) executives, the project manager, the procurement manager, and members of the project procurement team. Participants were selected based on a minimum of five years of project experience, direct involvement in material procurement or experience managing supply chain disruptions, and relevant knowledge of project management, procurement, and regulatory requirements. Research indicators were evaluated using four criteria: theoretical support (K1), relevance to the research problem (K2), measurability (K3), and conceptual distinctiveness (K4). Each criterion was scored on a three-point scale, with a maximum total score of 12. Indicators scoring 10–12 were retained, those scoring 7–9 were reviewed and refined or consolidated where necessary, and those scoring 4–6 were considered for exclusion.

Table 4. Research Stages and Analytical Framework

Stage	Activity
I. Problem identification	Identifying the impacts of supply chain disruption: material price increases, delivery delays, exchange rate changes, limited suppliers/resources, and declining productivity
II. Cause analysis	Analyzing dominant causes through field observation, secondary project documents, interviews with the project team, and FGD; Pareto diagram to rank priority factors
III. Development of alternatives	Formulating adaptive strategies based on organizational resilience, supply chain risk management, and adaptive strategy; FGD to validate the AHP hierarchy (goal, criteria, sub-criteria, and alternatives)

Stage	Activity
IV. Evaluation of solutions	Pairwise comparison with AHP; agreement on the best alternatives; FGD and SWOT analysis of the selected alternatives; stakeholder mapping; Cartesian diagram of internal and external factors
V. Adaptive strategy formulation	Recommending adaptive strategies to strengthen contractor resilience and maintain project performance

Source: Data processing (2026)

In the AHP, pairwise comparisons used the Saaty scale of 1–9, where 1 indicates that both elements are equally important, 3 that one element is slightly more important, 5 more important, 7 strongly more important, and 9 absolutely more important, with 2, 4, 6, and 8 as intermediate values and reciprocals for the reverse comparisons. Each matrix was normalized by dividing every element by its column total, and the priority value was the row average of the normalized matrix. Consistency was then checked as follows, where n is the number of elements and RI = 1.12 for n = 5:

$$\lambda max = \Sigma \text{ (priority value} \times \text{column total)}$$

$$CI = (\lambda max - n) / (n - 1)$$

$$CR = CI / RI;\ CR \leq 0.10 \text{ is consistent, } CR > 0.10 \text{ requires revision}$$

For the SWOT analysis, the FGD listed internal and external factors for each selected alternative. Each factor was given a priority, a weight (level of importance), and a rating on a scale of 1–5 (condition of the company or project toward the factor), and the score was obtained as weight × rating. The combinations SO (using strengths to exploit opportunities), ST (using strengths to face threats), WO (exploiting opportunities to overcome weaknesses), and WT (minimizing weaknesses and avoiding threats) were then formulated, as illustrated in Table 5. Finally, the Cartesian diagram positioned each alternative using X = Strengths – Weaknesses and Y = Opportunities – Threats, and stakeholder mapping assessed the power and interest of each party in relation to supply chain disruption.

Table 5. Example of the SWOT Strategy Matrix Used in the FGD

	Opportunities	Threats
Strengths	SO: utilizing the supplier network to obtain alternative materials	ST: utilizing the supplier network to anticipate supply chain disruption
Weaknesses	WO: developing local suppliers to reduce dependence on imported materials	WT: diversifying suppliers to reduce the risk of sanctions and supply disruption

Source: Data processing (2026)

RESULTS AND DISCUSSION

Causes of Supply Chain Disruption

Data from the cost estimate (initial material prices), monthly project reports (fluctuations in material prices), procurement reports (lead times and material schedules), and minutes of meetings (procurement constraints) were used to identify the occurrences of supply chain disruption in the project. The results of the Pareto analysis are presented in Table 6.

Table 6. Pareto Analysis of the Causes of Supply Chain Disruption

No.	Cause of Disruption	Frequency (times)	Percentage (%)
1	Geopolitics	16	21.62
2	Exchange rate fluctuation	15	20.27
3	Raw material price increase	13	17.57
4	Material scarcity	7	9.46
5	Financial disruption	6	8.11
6	Government policy	5	6.76
7	Supplier delay	4	5.41
8	Transportation disruption	3	4.05
9	Production disruption	3	4.05
10	Dependence on certain suppliers	2	2.70

Source: Data processing (2026)

Table 6 shows ten causes of supply chain disruption, five of which occurred most frequently in the field: geopolitics (16 times, 21.62%), exchange rate fluctuation (15 times, 20.27%), raw material price increases (13 times, 17.57%), material scarcity (7 times, 9.46%), and financial disruption (6 times, 8.11%). Together these five factors account for 77.03% of all occurrences, consistent with the Pareto principle that most problems stem from a few causes (Suherman & Cahyana, 2019). The main cause is geopolitics, which has a prolonged domino effect: geopolitical disruption triggers fluctuation of the rupiah exchange rate, which raises raw material prices and in turn leads to material scarcity and financial pressure. This chain of effects is in line with the ripple effect described by Dolgui et al. (2021) and the vulnerability of firms dependent on global supply chains highlighted by Baldwin and Freeman (2022). Internal factors such as financial disruption and dependence on certain suppliers also contribute, confirming that both internal and external factors shape disruption, and these factors require mitigation when the procurement strategy is set at the beginning of the project.

Indicator Screening and FGD Results

The FGD screened the 20 initial indicators using the four criteria described in the method, with the results presented in Table 7.

Table 7. Results of Indicator Screening

Code	Initial Indicator	K1	K2	K3	K4	Total	Decision
X1	Material price increase	3	3	3	3	12	Retained
X2	Supply chain disruption	3	3	2	2	10	Retained with specific definition
X3	Exchange rate fluctuation	3	2	3	3	11	Conditionally retained
X4	Material delay	3	3	3	2	11	Retained
X5	Material scarcity	2	3	3	2	10	Retained
R1	Risk anticipation	3	3	3	3	12	Retained
R2	Resource flexibility	3	3	3	3	12	Retained
R3	Supplier diversification	3	3	3	2	11	Retained with clarified definition
R4	Recovery capability	3	3	3	3	12	Retained
R5	Organizational learning	3	2	2	2	9	Evaluate; consider merging
S1	Material substitution	3	3	3	3	12	Retained
S2	Supplier diversification	3	3	3	2	11	Retained
S3	Work schedule adjustment	3	3	3	3	12	Retained

Code	Initial Indicator	K1	K2	K3	K4	Total	Decision
S4	Supplier information integration	3	3	2	3	11	Retained
S5	Negotiation with suppliers	2	2	3	2	9	Evaluate; consider merging
P1	Cost performance	3	3	3	3	12	Retained
P2	Time performance	3	3	3	3	12	Retained
P3	Work quality	3	3	3	3	12	Retained
P4	Work productivity	3	2	2	2	9	Evaluate
P5	Work safety	3	2	3	3	11	Conditionally retained

Source: Data processing (2026)

Table 7 shows that all five supply chain disruption indicators could be retained, although X2 must be defined carefully so that it does not repeat material delay and material scarcity. The resilience indicators were reduced from five to four core indicators, with organizational learning (R5) as a candidate for merging or elimination when the scope focuses on short-term operational responses; the adaptive strategy indicators were reduced to four, since negotiation with suppliers can be merged into supplier management; and the project performance indicators were reduced to three core indicators, namely cost, time, and quality, with safety retained only if it is an explicit part of the definition of project performance. Overall, the 20 initial indicators were reduced to 16 retained indicators with 4 elimination candidates, and the final recommended indicators and their operational definitions are shown in Table 8.

Table 8. Final Recommended Indicators and Operational Definitions

Variable	Code	Final Indicator	Operational Definition
Supply chain disruption	X1	Material price increase	Change in material prices affecting project procurement costs
	X2	Material delay	Late arrival of materials compared with the project schedule requirement
	X3	Material scarcity	Limited availability of materials needed to carry out the work
	X4	Exchange rate fluctuation	Change in exchange rates affecting the cost of imported materials or components
Contractor resilience	R1	Risk anticipation	Contractor's ability to identify and prepare responses to potential disruption
	R2	Resource flexibility	Ability to adjust labor, equipment, and other resources when disruption occurs
	R3	Supplier diversification	Ability to maintain alternative supply sources to reduce dependence
	R4	Recovery capability	Ability to restore project activities after disruption
Adaptive strategy	S1	Material substitution	Use of alternative materials that meet technical requirements
	S2	Supplier diversification	Obtaining materials from alternative suppliers
	S3	Work schedule adjustment	Adjusting the sequence or schedule of activities due to supply disruption
	S4	Supplier information integration	Improving information exchange and coordination with suppliers
Project performance	P1	Cost performance	Achievement of costs against the budget or cost target

Variable	Code	Final Indicator	Operational Definition
	P2	Time performance	Achievement of the schedule against the implementation plan
	P3	Work quality	Fulfilment of work specifications and quality requirements

Source: Data processing (2026)

Based on these indicators, the FGD agreed on five criteria to address supply chain disruption: (a) a procurement strategy for critical materials that plans long-lead-time materials at the beginning of implementation; (b) a competent administrative team with engineering and bureaucratic skills to speed up document completion; (c) an ideal cashflow strategy that prioritizes long-lead-time items and materials with limited stock to lock in prices and availability; (d) effective and efficient project operations aligned with the cashflow schedule to maintain financial stability; and (e) strict and periodic monitoring to keep the criteria on target. The stakeholders also proposed five alternatives in case the criteria cannot resolve the disruption: an integrated digital management system to monitor and manage procurement in real time; diversification by expanding the existing supplier network to increase supply chain visibility; internal policies that enforce orderly administration and build an early warning system; supplier risk management through periodic assessment of suppliers' financial condition and production capacity; and strict weekly evaluation and monitoring of emerging constraints. The resulting AHP hierarchy is shown in Figure 1.

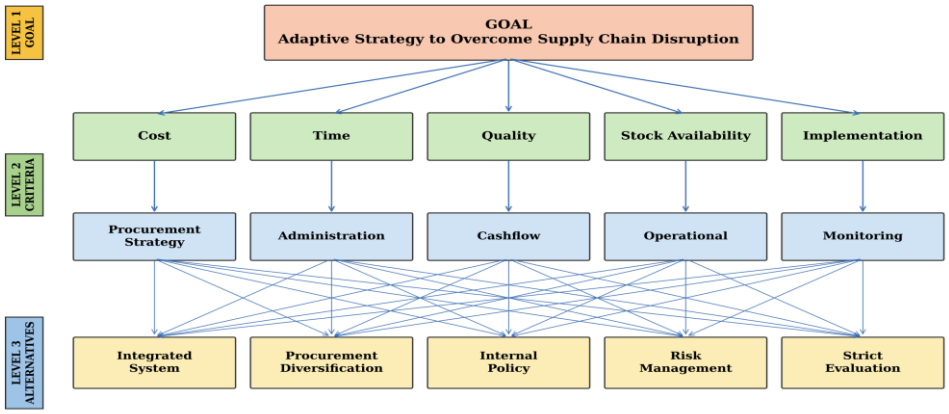


Figure 1. AHP Hierarchy for Determining the Adaptive Strategy
Source: Data processing (2026)

AHP Prioritization of Criteria and Alternatives

The pairwise comparison of the five criteria, the normalized priority values, and the consistency test are presented in Table 9.

Table 9. Pairwise Comparison Matrix and Priority Values of the Criteria

Criterion	Procurement Strategy	Administration	Cashflow	Operational	Monitoring	Priority
Procurement strategy	1	2	3	4	5	0.42

Criterion	Procurement Strategy	Administration	Cashflow	Operational	Monitoring	Priority
Administration	1/2	1	2	3	4	0.26
Cashflow	1/3	1/2	1	2	3	0.16
Operational	1/4	1/3	1/2	1	2	0.10
Monitoring	1/5	1/4	1/3	1/2	1	0.06
Column total	**2.28**	**4.08**	**6.83**	**10.50**	**15.00**	**–**

Note: λmax = 5.0905; CI = 0.0226; CR = 0.0202.

Source: Data processing (2026)

Table 9 shows that procurement strategy received the highest weight (41.62%), followed by administration (26.18%), cashflow (16.11%), operational (9.86%), and monitoring (6.24%). With λmax = 5.0905, CI = 0.0226, and CR = 0.0202 < 0.10, the judgments were consistent. The dominance of procurement strategy indicates that, in a project exposed to geopolitical and price shocks, early planning of critical long-lead-time materials is considered the most decisive response. The alternatives were then compared under each criterion, and the resulting local priorities and consistency ratios are summarized in Table 10.

Table 10. Local Priorities of Alternatives under Each Criterion and Consistency Test

Alternative	Procurement Strategy	Administration	Cashflow	Operational	Monitoring
Integrated system	0.25	0.27	0.22	0.44	0.42
Diversification	0.42	0.40	0.30	0.19	0.24
Internal policy	0.15	0.18	0.21	0.22	0.13
Risk management	0.10	0.10	0.20	0.08	0.11
Evaluation	0.07	0.06	0.08	0.07	0.09
λmax	**5.1414**	**4.9986**	**5.3138**	**5.2804**	**5.3131**
CI	**0.0354**	**-0.0004**	**0.0785**	**0.0701**	**0.0783**
CR	**0.0316**	**-0.0003**	**0.0701**	**0.0626**	**0.0699**

Source: Data processing (2026)

As shown in Table 10, all comparison matrices have CR values below 0.10, so the judgments are consistent. Diversification dominates under the procurement strategy (0.42), administration (0.40), and cashflow (0.30) criteria, whereas the integrated system dominates under the operational (0.44) and monitoring (0.42) criteria. The synthesis of criteria and alternative weights is presented in Table 11.

Table 11. Final Weights of Criteria and Alternatives

Rank	Criterion	Weight (%)	Alternative	Weight (%)
1	Procurement strategy	41.62	Integrated system	32
2	Administration	26.18	Diversification	31
3	Cashflow	16.11	Internal policy	18
4	Operational	9.86	Risk management	12
5	Monitoring	6.24	Evaluation	7

Source: Data processing (2026)

Table 11 shows that the integrated system obtained the highest alternative weight (32%), but diversification followed with a very small difference (31%), while internal policy (18%), risk management (12%), and evaluation (7%) were far behind. Because the two leading alternatives were nearly equal, the three highest alternatives, namely the integrated system, procurement diversification, and internal policy, were carried forward to the SWOT analysis to confirm the most optimal strategy under the actual project conditions.

SWOT Analysis of the Selected Alternatives

The SWOT analysis was conducted by the stakeholders consisting of the SVP Division, SVP SCM, VP SCM, project manager, project procurement manager, and procurement team, considering the cost estimate, monthly reports, procurement reports, and minutes of meetings. The factors, weights, ratings, and scores for the three alternatives are presented in Tables 12–14.

Table 12. SWOT Weights, Ratings, and Scores of the Integrated System Alternative

Code	Factor	Priority	Weight	Rating	Score
S1	Integration of supplier and contractor data and information	4	0.06	4	0.25
S2	More effective stakeholder coordination	3	0.03	2	0.05
S3	Faster (real-time) decisions	4	0.05	3	0.15
S4	Process and resource efficiency	3	0.04	2	0.08
S5	Real-time monitoring and control	4	0.05	3	0.16
W1	Dependence on technology and networks	2	0.05	3	0.15
W2	Data quality and consistency not yet uniform	4	0.06	2	0.11
W3	Uneven staff competence in using the system	3	0.05	4	0.18
W4	Relatively high implementation and maintenance costs	4	0.06	2	0.12
W5	Resistance to change and stakeholder integration	4	0.05	2	0.10
O1	Development of digital technology and information systems	4	0.05	4	0.21
O2	Growing need for transparency and speed of information	4	0.04	2	0.09
O3	Development of supplier and alternative supplier databases	4	0.05	2	0.10
O4	Increasing opportunities for stakeholder collaboration	4	0.05	5	0.24
O5	Development of early detection of supply chain disruption	4	0.06	2	0.12
T1	Data security and leakage risks	4	0.06	4	0.24
T2	Technology system disruption or failure	2	0.04	3	0.13
T3	Different systems and standards among stakeholders	4	0.05	2	0.10
T4	Rapid technological change	3	0.05	2	0.10
T5	Dependence on external vendors	4	0.06	3	0.17
	Total		**1.00**	**56**	**2.84**

Source: Data processing (2026)

Table 13. SWOT Weights, Ratings, and Scores of the Procurement Diversification Alternative

Code	Factor	Priority	Weight	Rating	Score
S1	Several suppliers for the same material	4	0.06	5	0.29
S2	Availability of alternative material sources	4	0.05	5	0.23

Code	Factor	Priority	Weight	Rating	Score
S3	Reduced dependence on a single supplier	2	0.06	5	0.29
S4	Flexibility in choosing material sources and suppliers	3	0.05	5	0.18
S5	Improved resilience and continuity of the supply chain	3	0.05	5	0.25
W1	Relatively high cost of managing many suppliers	4	0.05	3	0.16
W2	More complex coordination among suppliers	3	0.05	4	0.19
W3	Material quality consistency harder to control	4	0.05	4	0.20
W4	Lower bargaining power due to divided volumes	3	0.04	3	0.12
W5	Requires a complex monitoring and evaluation system	4	0.05	4	0.18
O1	Development of an alternative supplier network	4	0.06	4	0.23
O2	Greater use of local suppliers and materials	3	0.05	3	0.16
O3	Use of digital technology to find and manage suppliers	3	0.05	3	0.14
O4	Strategic cooperation with several suppliers	2	0.05	5	0.25
O5	Improved capability to face supply chain disruption	4	0.05	3	0.16
T1	Fluctuation and increase in material prices	4	0.05	4	0.22
T2	Geopolitical disruption and international economic sanctions	3	0.05	4	0.19
T3	Transportation and logistics disruption	2	0.05	3	0.14
T4	Limited capacity of alternative suppliers	3	0.05	3	0.14
T5	Changes in government policies and regulations	3	0.05	2	0.10
	Total		**1.00**	**70**	**3.82**

Source: Data processing (2026)

Table 14. SWOT Weights, Ratings, and Scores of the Internal Policy Alternative

Code	Factor	Priority	Weight	Rating	Score
S1	Flexible material procurement policy	4	0.06	4	0.23
S2	Clear and available risk management SOP	4	0.05	4	0.22
S3	Responsive internal decision-making	4	0.05	3	0.15
S4	Policy on the use of alternative suppliers	4	0.05	2	0.09
S5	Strong management support for project continuity	4	0.05	2	0.10
W1	Procurement policy not flexible enough in facing disruption	4	0.05	2	0.11
W2	Decision-making requires many stages	3	0.06	3	0.17
W3	SOP for handling supply chain disruption not yet optimal	2	0.05	3	0.15
W4	Limited authority of the project team in decision-making	3	0.05	2	0.09
W5	Internal policies not evaluated and updated periodically	3	0.05	2	0.09
O1	Development of more adaptive risk management policies	3	0.05	3	0.16
O2	Use of digital technology in project and supply chain management	4	0.05	2	0.10
O3	Policy development on alternative suppliers and materials	2	0.04	2	0.09
O4	Staff competence improvement through training and capacity building	4	0.05	3	0.15
O5	Contingency policies for external disruption	4	0.05	3	0.15
T1	Changes in government regulations and policies	4	0.05	4	0.22
T2	Economic and geopolitical uncertainty	3	0.05	4	0.20
T3	Rapid changes and disruptions in the supply chain	2	0.04	3	0.13
T4	Rapid technological development	2	0.04	3	0.13

Code	Factor	Priority	Weight	Rating	Score
T5	Mismatch between internal policies and field conditions	3	0.05	2	0.10
	Total		**1.00**	**56**	**2.83**

Source: Data processing (2026)

Tables 12–14 show that the integrated system is strong in data integration and real-time monitoring but weakened by uneven staff competence and threatened by data security risks, with a total score of 2.84. Procurement diversification has the strongest internal position because all of its strengths, such as having several suppliers for the same material and reduced dependence on a single supplier, received the maximum rating of 5, and its main opportunity is strategic cooperation with several suppliers; it obtained the highest total score of 3.82. Internal policy benefits from flexible procurement policies and a clear risk management SOP, but it is constrained by lengthy decision-making stages and threatened by regulatory changes, with a total score of 2.83. The internal and external positions of the three alternatives are summarized in Table 15 and illustrated in Figure 2.

Table 15. IFAS–EFAS Positions, Total SWOT Scores, and Ranking of the Alternatives

Alternative	S	W	X (S–W)	O	T	Y (O–T)	Quadrant	Total	Rank
Procurement diversification	1.24	0.86	0.37	0.93	0.79	0.15	I	3.82	1
Integrated system	0.69	0.66	0.03	0.76	0.73	0.02	I	2.84	2
Internal policy	0.79	0.61	0.17	0.65	0.78	-0.13	II	2.83	3

Note: S = strengths, W = weaknesses, O = opportunities, T = threats.

Source: Data processing (2026)

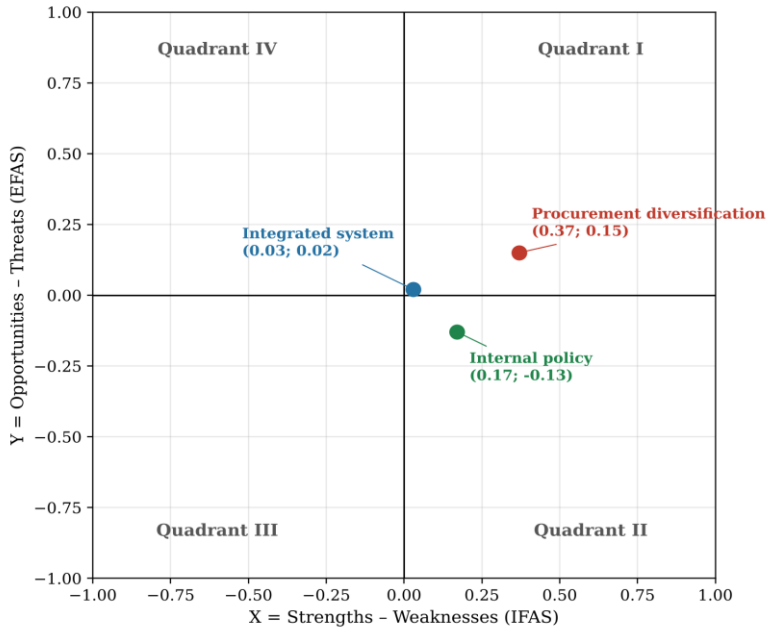


Figure 2. Cartesian Diagram of the SWOT Positions of the Alternative Strategies

Source: Data processing (2026)

Table 15 and Figure 2 show that procurement diversification (X = 0.37; Y = 0.15) lies in Quadrant I, which represents a favorable situation in which strengths should be used to exploit opportunities through a growth-oriented strategy (Ariwibowo, 2025). The integrated system (X = 0.03; Y = 0.02) is also in Quadrant I but very close to the origin, indicating that its strengths barely exceed its weaknesses and its opportunities barely exceed its threats. Internal policy (X = 0.17; Y = -0.13) lies in Quadrant II, where the organization faces threats and must use its strengths to overcome them. These results reveal a shift in the preferred strategy: although AHP slightly favored the integrated system, the stakeholders chose procurement diversification after considering the project conditions, because under prolonged geopolitical disruption, mapping and diversifying partners is the most effective way to secure material availability. This finding supports Baldwin and Freeman (2022), who emphasize supplier diversification as a resilience strategy against global shocks, and Cozzolino and Verona (2024), who regard strategic flexibility and resource reconfiguration as the core of adaptive strategy.

Stakeholder Mapping

The power and interest of the parties influencing supply chain disruption were mapped as shown in Table 16.

Table 16. Stakeholder Mapping of Supply Chain Disruption

Stakeholder	Power	Interest	Position	Engagement Strategy
Owner, represented by the Commitment Making Official (PPK) and Field Technical Implementation Official (PPTK)	5	5	Manage closely	Strategic coordination meetings
Main contractor, represented by the SVP Division, SVP SCM, VP SCM, project manager, procurement manager, and procurement team	4	5	Manage closely	Decision-making; daily coordination; procurement monitoring; coordination of needs
Contractor partners, represented by subcontractors and suppliers of materials and equipment	3	5	Keep informed and keep satisfied	Updating material schedules; monitoring stock, delivery, and availability
Government, represented by regulatory and policy-making bodies	5	5	Keep satisfied	Regulatory compliance

Source: Data processing (2026)

Table 16 indicates that the owner has very high power in determining the budget, completion targets, change policies, material approvals, and other decisions; it can accelerate decision-making during disruption, but suppliers' inability to meet the owner's technical specifications, which often occurs for special or imported materials, and late material approvals, which often wait for all users to agree on the design, can delay the work. The main contractor is the most important stakeholder because it deals directly with procurement, suppliers, labor, schedules, and materials; immature procurement planning and inappropriate supplier selection are potential sources of disruption, whereas grouping suppliers by their specific specialization creates a supplier diversification data bank that can serve as an

alternative when disruption occurs. Partners and subcontractors have high influence on material availability, price stability, quantities, and supply continuity, so they may be both a source of disruption and a solution. Government regulation maintains the stability of the economic ecosystem and ensures compliance with quality standards, but slow permits and bureaucracy, as well as unclear standardization, can delay material procurement. Building good cooperation among stakeholders is therefore an appropriate step to suppress the impact of supply chain disruption, consistent with the power–interest approach of Zhu et al. (2024).

Overall, the results show that supply chain disruption in the Padat Karya Flats Phase II project is influenced by internal and external factors, including material delay, price increases, material scarcity, dependence on suppliers, transportation disruption, policy changes, and geopolitical disruption. The owner, the main contractor, partners or suppliers, and the government are key stakeholders in managing the disruption. The integration of FGD, AHP, SWOT, the Cartesian diagram, and stakeholder mapping changed the preferred alternative from the integrated system to procurement diversification, which provides a basis for contractors to strengthen their ability to anticipate, respond to, and adapt to disruption, in line with the resilience dimensions proposed by Duchek (2020), and to maintain time, cost, and quality performance (Kumar et al., 2023).

CONCLUSION

This study concluded that supply chain disruptions in the Phase II Construction Project of the Padat Karya Flats resulted from complex interactions between internal and external factors. The dominant factors included geopolitical disruptions (21.62%), fluctuations in the Indonesian rupiah exchange rate (20.27%), increases in raw material prices (17.57%), material shortages (9.46%), and financial disruptions (8.11%), which collectively contributed to on-site construction delays and reduced project performance. Focus group discussions (FGDs) involving contractor stakeholders, followed by an Analytic Hierarchy Process (AHP) assessment, identified procurement strategy as the highest-priority criterion, with an integrated procurement system emerging as the leading strategic alternative (32%), closely followed by procurement diversification (31%). However, strengths, weaknesses, opportunities, and threats (SWOT) analysis, supported by Cartesian quadrant analysis and stakeholder mapping involving the project owner, contractors, suppliers, and relevant government authorities, identified procurement diversification as the preferred strategy, with a total score of 3.82 and a position in Quadrant I. This strategy was followed by integrated procurement systems (2.84) and internal procurement policies (2.83). Accordingly, contractors should strengthen supply chain resilience by diversifying their supplier networks, establishing alternative supply sources, maintaining safety stock for critical materials, and improving material substitution capabilities. They should also implement integrated supply chain monitoring systems and develop comprehensive contingency plans covering alternative suppliers, critical and substitute materials, emergency procurement procedures, and decision-making protocols during disruptions. Future research should examine multiple construction projects with different characteristics to improve the generalizability of the findings and integrate SWOT–AHP analysis with advanced multicriteria decision-making methods, such as fuzzy AHP, the Analytic Network Process (ANP), the Technique for Order Preference by Similarity to Ideal

Solution (TOPSIS), the Decision-Making Trial and Evaluation Laboratory (DEMATEL), or the Delphi method, to better account for uncertainty and interdependencies among supply chain disruption factors.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the conduct of the research, preparation, or publication of this article.

AUTHOR CONTRIBUTIONS

All authors contributed to the preparation of this article. Ahmad Ainun Najib and Bambang Endro Yuwono were responsible for the conceptualization of the study, data collection and analysis, interpretation of the results, and manuscript preparation, as well as the review, editing, and final approval of the manuscript.

GENERATIVE AI STATEMENT

The authors declare that no generative artificial intelligence was used in the preparation of this article.

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