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Prioritizing Green Material Supply Chain Criteria in The Jakarta LRT Project Using The Analytical Hierarchy Process (AHP)

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ABSTRACT

The increasing demand for sustainable infrastructure requires construction projects to integrate environmental considerations into material supply chain management. This study aims to identify and prioritize green material supply chain criteria in the Jakarta Light Rail Transit (LRT) project. An Analytical Hierarchy Process (AHP) approach was employed to evaluate the relative importance of green supply chain criteria based on expert judgments. The assessment involved five main criteria: Stakeholder Collaboration, Green Construction, Green Procurement, Waste Management, and Green Logistics, comprising fifteen subcriteria. The results indicate that Stakeholder Collaboration obtained the highest priority weight of 21.86%, followed by Green Construction (20.81%), Green Procurement (20.73%), Waste Management (18.54%), and Green Logistics (18.05%). At the subcriterion level, Environmentally Friendly Supplier Selection achieved the highest local priority under Green Procurement (38.84%), followed by Shared Environmental Commitment (37.46%) and Efficient Use of Concrete Materials (36.80%) within their respective criteria. The consistency test produced a Consistency Ratio (CR) of 0.0169, indicating that the expert judgments were highly consistent. The findings provide a structured basis for prioritizing environmental practices in material supply chain management and support project stakeholders in developing more integrated and sustainable approaches to procurement, construction, waste management, and logistics in urban rail infrastructure projects.

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1. INTRODUCTION

The construction industry plays an important role in supporting economic and infrastructure development; however, its activities are also associated with substantial environmental impacts arising from material extraction, manufacturing, transportation, construction activities, and waste generation. The construction supply chain is particularly important because material-related activities extend from upstream suppliers to transportation and project-site operations. Consequently, improving the sustainability of construction supply chains requires attention not only to construction processes but also to how materials are selected, procured, transported, used, and managed throughout the project lifecycle. Recent studies have emphasized that the construction supply chain is a critical component of decarbonization because the production, transportation, and utilization of construction materials contribute significantly to environmental impacts and greenhouse gas emissions (Durgam and Ramani, 2025).

Green Supply Chain Management (GSCM) has emerged as an approach for integrating environmental considerations into conventional supply chain activities. In the construction sector, GSCM encompasses practices related to green procurement, environmentally responsible material selection, transportation and logistics, waste management, supplier management, and collaboration among supply chain stakeholders. In Indonesia, previous research has developed a GSCM framework for the construction sector by identifying and ranking green practices based on stakeholder preferences. The findings highlight practices such as reducing hazardous materials, managing construction waste, reusing or reselling unused products and components, and strengthening environmental management at the organizational level (Wiguna, et al, 2021).

The importance of sustainable construction materials has become increasingly evident as the construction industry seeks to reduce resource consumption and environmental impacts. Sustainable material selection involves consideration of multiple

criteria, including environmental performance, resource efficiency, recyclability, durability, economic aspects, and social considerations. A recent study applying the Analytical Hierarchy Process (AHP) to sustainable construction material assessment demonstrated that AHP can be used to identify and prioritize critical criteria for material selection in construction projects (Qian, et al, 2024). In addition, recent research on sustainable construction material supply chains has emphasized the need for systematic decision-making approaches that consider environmental and operational factors simultaneously.

Despite the increasing attention to green supply chain practices, implementing a green material supply chain in construction projects remains challenging. Construction projects involve numerous stakeholders with different interests, organizational capabilities, contractual responsibilities, and environmental priorities. Fragmented supply chains, limited coordination, lack of knowledge, and insufficient integration among stakeholders may hinder the adoption of green practices. Recent research indicates that fragmentation and inadequate information sharing remain important challenges in achieving a more sustainable construction supply chain. Moreover, stakeholder engagement, government support, and the availability of appropriate green materials and suppliers can influence the implementation of sustainable construction practices (Adhi and Muslim, 2024).

The need for effective prioritization is particularly important in large-scale transportation infrastructure projects, where material requirements, procurement activities, logistics, environmental impacts, and stakeholder involvement are complex. The Jakarta Light Rail Transit (LRT) project represents an important urban transportation infrastructure development in Indonesia. Beyond its function as a mass transportation system, the project provides a relevant context for examining sustainable practices associated with construction materials. The LRT Jakarta sustainability reporting indicates the implementation of green and smart building concepts, including energy and water efficiency and the use of environmentally friendly materials in relevant facilities. Therefore, examining the priority of green material supply chain criteria in the LRT Jakarta project is relevant for strengthening sustainable infrastructure practices.

Previous studies have examined GSCM in the construction industry using various decision-making approaches. For example, Wiguna et al. developed a GSCM framework for the Indonesian construction sector by combining pairwise comparison and TOPSIS to weight and rank green practices. Other research has applied AHP to prioritize drivers, enablers, and barriers to GSCM adoption in the construction industry, demonstrating the usefulness of hierarchical decision-making for dealing with multiple sustainability criteria (Mojumder and Singh, 2021). More recent research has also developed multi-criteria approaches to evaluate GSCM performance based on environmental, economic, organizational, and social criteria. However, there remains a need for project-specific research that focuses specifically on prioritizing green material supply chain criteria in urban rail infrastructure projects, particularly in the Indonesian context.

The use of the Analytical Hierarchy Process (AHP) provides a systematic approach to address this problem because it enables decision-makers to decompose a complex decision into hierarchical criteria and subcriteria, conduct pairwise comparisons, calculate relative weights, and establish priority rankings. This approach is particularly appropriate when decisions involve multiple criteria and require expert judgment. Therefore, AHP can provide a structured basis for determining which green material supply chain criteria should receive greater attention in the management of construction projects.

Based on this research gap, this study aims to identify and prioritize the criteria of green material supply chain in the Jakarta LRT project using the Analytical Hierarchy Process (AHP). The study is expected to contribute to the development of sustainable construction supply chain practices by providing empirical evidence regarding the relative importance of green material-related criteria. The results are also expected to provide practical guidance for project owners, contractors, consultants, suppliers, and other stakeholders in allocating attention and resources to the most important aspects of green material supply chain management.

2. RESEARCH METHODOLOGY

2.1 Research Design

This study employed a **quantitative research approach** using the **Analytical Hierarchy Process (AHP)** as a multi-criteria decision-making method. AHP was selected because the objective of the study was to determine the relative priorities of several criteria in the implementation of a green material supply chain in the Jakarta LRT project. AHP enables a complex decision problem to be structured hierarchically and allows decision-makers to compare criteria in pairs to determine their relative importance. The method has also been applied in previous studies to prioritize green supply chain practices and criteria in the construction industry (Mojumder and Singh, 2021).

The research was conducted through several stages: (1) identification of criteria and subcriteria, (2) development of the AHP hierarchy, (3) selection of expert respondents, (4) pairwise comparison, (5) calculation of priority weights, (6) consistency testing, and (7) determination of the final priority ranking.

2.2 Identification of Criteria and Subcriteria

The criteria and subcriteria of the green material supply chain were identified through a review of relevant literature on green supply chain management, sustainable construction materials, green procurement, green logistics, construction waste management, and sustainable construction practices. The initial criteria were subsequently evaluated and validated by experts with relevant experience in construction projects and supply chain management.

Previous research has demonstrated that green supply chain management in construction involves various dimensions, including green purchasing/procurement, green transportation, green construction, waste management, and environmental performance.

The criteria and subcriteria identified in this study were then organized into an AHP hierarchy consisting of three levels:

- **Level 1:** Research objective – prioritization of green material supply chain criteria;
- **Level 2:** Main criteria;
- **Level 3:** Subcriteria.

The hierarchy was developed to represent the relationship between the overall objective, the main criteria, and the corresponding subcriteria.

2.3 AHP Questionnaire

Data were collected through an AHP questionnaire based on **pairwise comparisons**. Respondents were asked to compare the relative importance of two criteria at the same hierarchical level with respect to the criterion immediately above them.

The comparison employed Saaty's fundamental **1–9 scale**, as presented in Table 1.

Table 1. Saaty's fundamental 1–9 scale

Intensity	Definition	Explanation
1	Equal importance	Two criteria contribute equally
3	Moderate importance	One criterion is moderately more important
5	Strong importance	One criterion is strongly more important
7	Very strong importance	One criterion is very strongly more important
9	Extreme importance	One criterion is extremely more important
2, 4, 6, 8	Intermediate values	Compromise between two adjacent judgments
Reciprocal	Opposite comparison	If criterion A is assigned a value of a relative to B, B has a value of $1/a$ relative to A

The pairwise comparison approach allows the relative importance of each criterion to be quantified and subsequently converted into priority weights. Similar procedures have been applied in construction-sector GSCM studies using AHP or pairwise comparison.

2.4 AHP Data Processing

The AHP analysis consisted of the following procedures.

Step 1 – Constructing the pairwise comparison matrix

For n criteria, a pairwise comparison matrix A was constructed as:

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix}$$

where a_{ij} represents the relative importance of criterion ii compared with criterion jj, and $a_{ji}=1/a_{ij}$.

Step 2 – Normalizing the matrix

Each element of the pairwise comparison matrix was normalized by dividing the value of each element by the sum of its respective column:

$$n_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$$

Step 3 – Calculating priority weights

The priority weight of each criterion was obtained by calculating the average of the normalized values in each row:

$$w_i = \frac{\sum_{j=1}^{n} n_{ij}}{n}$$

The resulting w_i represents the relative priority weight of each criterion.

Step 4 – Consistency testing

Because pairwise judgments may contain inconsistencies, the consistency of the comparison matrix was evaluated using the **Consistency Index (CI)** and **Consistency Ratio (CR)**.

The maximum eigenvalue λmax was first determined, followed by:

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

The Consistency Ratio was then calculated as:

$$CR = \frac{CI}{RI}$$

where:

- CI = Consistency Index;
- CR = Consistency Ratio;
- RI = Random Index; and
- nn = number of criteria.

A pairwise comparison matrix is considered sufficiently consistent when:

$$CR \leq 0.10$$

If the CR value exceeds 0.10, the pairwise judgments should be reviewed because the level of inconsistency is considered too high. This procedure is also reflected in previous AHP-based construction GSCM research, which calculates the comparison matrix, normalized matrix, criterion weights, and consistency ratio before determining the priorities (Wiguna, et al, 2021).

2.5 Determination of Priority Ranking

After the consistency test, the final priority of each criterion and subcriterion was determined based on its **priority weight**. A higher weight indicates a greater relative importance in achieving the objective of implementing a green material supply chain.

The global priority of each subcriterion was calculated by multiplying its local weight by the weight of its corresponding main criterion:

$$GP_{ij} - W_i \times W_{ij}$$

where:

- GP_{ij}= global priority of subcriterion jj under criterion ii;
- W_i= priority weight of the main criterion; and
- W_{ij}= local priority weight of the subcriterion.

The criteria and subcriteria were subsequently ranked from the highest to the lowest global priority. The highest-ranked criterion was interpreted as the **most important criterion** requiring attention in managing the green material supply chain of the Jakarta LRT project.

3. RESULTS AND DISCUSSION

A. Characteristics of Expert Respondents

The distribution of respondents based on job position indicates that Site QHSE Officers constituted the largest group, with 11 respondents (30%)**,** followed by Site Implementers with 10 respondents (27%)**.** Contract Administration Staff accounted for 4 respondents (11%)**,** while Project Managers, Supervisors, and Logistics personnel each consisted of 3 respondents (8%)**.** Meanwhile, Termyn Quantity Surveyors (QS Termyn), Site QHSE Managers, and Occupational Health and Safety (K3) personnel each contributed 1 respondent (3%)**.**

Overall, the respondents represented various professional positions involved in the implementation and management of the Jakarta LRT construction project. The diversity of respondents is relevant to the AHP analysis because the assessment of green

material supply chain priorities requires perspectives from professionals involved in quality, health, safety and environmental management, construction implementation, contract administration, project supervision, logistics, and quantity surveying. Their professional involvement provides a broad basis for evaluating the relative importance of the identified criteria and subcriteria.

B. AHP Hierarchical Structure

Table 2. AHP Structural Hierarchy for Green Material Supply Chain Prioritization

Level	Hierarchy Component	Code	Criteria / Subcriteria
Level 1	**Goal**	G	**Prioritization of Green Material Supply Chain Criteria in the Jakarta LRT Project**
Level 2	**Main Criterion**	KS	**Stakeholder Collaboration**
Level 3	Subcriterion	KL	Shared Environmental Commitment
Level 3	Subcriterion	BI	Information Sharing and Transparency
Level 3	Subcriterion	KM	Management Commitment and Policy
Level 2	**Main Criterion**	GP	**Green Procurement**
Level 3	Subcriterion	PS	Environmentally Friendly Supplier Selection
Level 3	Subcriterion	PM	Use of Environmentally Friendly Materials
Level 3	Subcriterion	ER	Supplier Track Record Evaluation
Level 2	**Main Criterion**	GC	**Green Construction**
Level 3	Subcriterion	EB	Efficient Use of Concrete Materials
Level 3	Subcriterion	KE	Resource and Energy Conservation
Level 3	Subcriterion	TK	Environmentally Friendly Technology/Methods
Level 2	**Main Criterion**	ML	**Waste Management**
Level 3	Subcriterion	R3	3R Application to Concrete Waste
Level 3	Subcriterion	DP	Concrete Debris Recycling
Level 3	Subcriterion	AW	Fleet Washout Wastewater Management
Level 2	**Main Criterion**	GL	**Green Logistics**
Level 3	Subcriterion	OR	Transportation Route Optimization
Level 3	Subcriterion	ME	Fleet Emission and Maintenance Management
Level 3	Subcriterion	PN	Environmentally Friendly Material Storage

C. Identification of Green Material Supply Chain Criteria

The identification of green material supply chain criteria was conducted to establish the decision hierarchy for prioritizing green supply chain practices in the Jakarta LRT project. The criteria were developed based on a review of the literature on green supply chain management (GSCM), sustainable construction, green procurement, construction waste management, green logistics, and stakeholder collaboration. The identified criteria were subsequently adjusted to the characteristics of urban rail infrastructure construction and validated based on the relevance of each criterion to material supply chain activities in the project.

Five main criteria were identified: Stakeholder Collaboration (KS), Green Procurement (GP), Green Construction (GC), Waste Management (ML), and Green Logistics (GL). These criteria represent the major dimensions influencing the environmental performance of material supply chain management in the Jakarta LRT project. Stakeholder Collaboration (KS) represents the extent to which project stakeholders share environmental objectives, information, and management responsibilities. This criterion consists of Shared Environmental Commitment (KL), Information Sharing and Transparency (BI), and Management Commitment and Policy (KM). Green Procurement (GP) concerns the integration of environmental considerations into the selection and procurement of construction materials and suppliers. Its subcriteria include Environmentally Friendly Supplier Selection (PS), Use of Environmentally Friendly Materials (PM), and Supplier Track Record Evaluation (ER).

Green Construction (GC) focuses on the implementation of construction practices that improve resource efficiency and reduce environmental impacts during project execution. The subcriteria comprise Efficient Use of Concrete Materials (EB), Resource and Energy Conservation (KE), and Environmentally Friendly Technology/Methods (TK). Waste Management (ML) addresses the reduction, reuse, recycling, and environmentally responsible treatment of construction waste generated during project activities. The identified subcriteria are 3R Application to Concrete Waste (R3), Concrete Debris Recycling (DP), and Fleet Washout Wastewater Management (AW).

Green Logistics (GL) focuses on minimizing environmental impacts associated with the transportation and storage of construction materials. It consists of Transportation Route Optimization (OR), Fleet Emission and Maintenance Management

(ME), and Environmentally Friendly Material Storage (PN)**.** Thus, the AHP hierarchy consists of one overall goal, five main criteria, and fifteen subcriteria**.** The resulting hierarchy provides a structured basis for the pairwise comparison and priority-weighting process in the subsequent AHP analysis.

D. Pairwise Comparison of Main Criteria

The five main criteria identified in the green material supply chain hierarchy were evaluated using the Analytical Hierarchy Process (AHP) through pairwise comparisons. The purpose of the pairwise comparison was to determine the relative importance of each criterion with respect to the overall goal of prioritizing green material supply chain practices in the Jakarta LRT project.

The comparison was conducted using Saaty's 1–9 fundamental scale, where a value of 1 indicates equal importance between two criteria, while higher values indicate increasing preference of one criterion over another. The reciprocal value was assigned to the opposite comparison. The judgments obtained from the respondents were aggregated to develop the comparison matrix for the five main criteria: Stakeholder Collaboration (KS), Green Procurement (GP), Green Construction (GC), Waste Management (ML), and Green Logistics (GL). Based on the AHP calculation, the resulting priority weights of the five main criteria are presented below.

Table 3. Priority Weights of Main Criteria

Rank	Main Criterion	Code	Priority Weight
1	Stakeholder Collaboration	KS	21.86%
2	Green Construction	GC	20.81%
3	Green Procurement	GP	20.73%
4	Waste Management	ML	18.54%
5	Green Logistics	GL	18.05%
	Total		100.00%

The results indicate that Stakeholder Collaboration (KS) has the highest priority weight at 21.86%**,** followed by Green Construction (GC) at 20.81% and Green Procurement (GP) at 20.73%**.** Meanwhile, Waste Management (ML) and Green Logistics (GL) obtained weights of 18.54% and 18.05%**,** respectively.

E. Priority Weights and Consistency Test

The priority weights of the main criteria were calculated from the normalized pairwise comparison matrix using the Analytical Hierarchy Process (AHP). The priority weight represents the relative importance of each criterion in achieving the overall goal of prioritizing green material supply chain practices in the Jakarta LRT project.

1). Consistency Test

The consistency of the pairwise comparison judgments was evaluated using the **Consistency Index (CI)** and **Consistency Ratio (CR)**. The AHP consistency test is necessary to determine whether the judgments provided by the respondents are logically consistent. Therefore, the AHP analysis should report the calculated λmax, CI, and CR values to demonstrate the reliability of the pairwise comparison judgments.

Table 4. Consistency Test of Main Criteria

Parameter	Result
Number of criteria (n)	5
Maximum eigenvalue (λmaxf_0\lambda_{\max})	5,0759
Consistency Index (CI)	0,0190
Random Index (RI)	1.12
Consistency Ratio (CR)	0,0169
Consistency criterion	CR ≤ 0.10
Judgment consistency	Consistent

The consistency test indicates that the pairwise comparison judgments are consistent, as the resulting Consistency Ratio (CR) is below the maximum acceptable threshold of 0.10. Therefore, the priority weights obtained from the AHP analysis can be considered reliable and can be used for the subsequent analysis of the local and global priorities of the subcriteria.

To identify the most important green material supply chain practices across all dimensions, the local priorities were multiplied by the corresponding weights of the main criteria to obtain the global priorities and overall ranking of the fifteen subcriteria.

2) Local Priority of Subcriteria

Following the determination of the priority weights of the five main criteria, the AHP analysis was extended to the subcriteria. The local priority represents the relative importance of each subcriterion within its respective main criterion. The local weights were obtained from the pairwise comparison of subcriteria under each criterion and were subsequently normalized so that the weights within each criterion sum to 100%.

Table 5. Local Priority of Subcriteria

Main Criterion	Code	Subcriterion	Local Priority
Stakeholder Collaboration (KS)	KL	Shared Environmental Commitment	**37.46%**
	BI	Information Sharing and Transparency	**33.63%**
	KM	Management Commitment and Policy	**28.91%**
Green Procurement (GP)	PS	Environmentally Friendly Supplier Selection	**38.84%**
	PM	Use of Environmentally Friendly Materials	**32.27%**
	ER	Supplier Track Record Evaluation	**28.90%**
Green Construction (GC)	EB	Efficient Use of Concrete Materials	**36.80%**
	KE	Resource and Energy Conservation	**31.88%**
	TK	Environmentally Friendly Technology/Methods	**31.33%**
Waste Management (ML)	R3	3R Application to Concrete Waste	**35.44%**
	DP	Concrete Debris Recycling	**34.48%**
	AW	Fleet Washout Wastewater Management	**30.07%**
Green Logistics (GL)	OR	Transportation Route Optimization	**36.13%**
	ME	Fleet Emission and Maintenance Management	**32.55%**
	PN	Environmentally Friendly Material Storage	**31.32%**

The results indicate that Environmentally Friendly Supplier Selection (PS) has the highest local priority among the subcriteria under Green Procurement, with a weight of **38.84%**. This is followed by Shared Environmental Commitment (KL) under Stakeholder Collaboration at **37.46%**, Efficient Use of Concrete Materials (EB) under Green Construction at **36.80%**, and Transportation Route Optimization (OR) under Green Logistics at **36.13%**.

Within Stakeholder Collaboration, Shared Environmental Commitment (KL) is the most important subcriterion, followed by Information Sharing and Transparency (BI) and Management Commitment and Policy (KM)**.** This suggests that a common environmental commitment among project stakeholders is considered more important than formal management policies alone.

For Green Procurement, Environmentally Friendly Supplier Selection (PS) receives the highest local priority. This indicates that selecting suppliers based on their environmental performance is considered a key mechanism for implementing green material supply chain practices. Within Green Construction**,** Efficient Use of Concrete Materials (EB) ranks first, emphasizing the importance of minimizing material consumption and improving material utilization during construction activities. For Waste Management, 3R Application to Concrete Waste (R3) has the highest local priority, highlighting the importance of reducing, reusing, and recycling concrete-related waste. Meanwhile, Transportation Route Optimization (OR) is the leading subcriterion under Green Logistics, reflecting the importance of reducing transportation distance, travel time, fuel consumption, and associated emissions.

Overall, the local priority results demonstrate that each main criterion has a different dominant subcriterion. These local priorities are subsequently combined with the priority weights of the main criteria to obtain the global priority ranking of all fifteen subcriteria.

3) Priority of Green Material Supply Chain Criteria

The AHP analysis was conducted to determine the relative priority of criteria and subcriteria in the implementation of a green material supply chain in the Jakarta LRT project. Five main criteria were identified, namely Stakeholder Collaboration, Green Procurement, Green Construction, Waste Management, and Green Logistics**.** The resulting priority weights indicate differences in the relative importance of each criterion in supporting green material supply chain practices.

Table 6. The results of the AHP analysis

Rank	Criteria	Criterion Weight
1	Stakeholder Collaboration (KS)	**21.86%**
2	Green Construction (GC)	**20.81%**

3	Green Procurement (GP)	**20.73%**
4	Waste Management (ML)	**18.54%**
5	Green Logistics (GL)	**18.05%**

The results show that Stakeholder Collaboration (KS) has the highest priority, with a weight of **21.86%**. This finding indicates that collaboration among stakeholders is considered the most important criterion in implementing a green material supply chain in the Jakarta LRT project. Construction projects involve multiple parties with different responsibilities, including project owners, contractors, consultants, suppliers, and other stakeholders. Therefore, achieving environmental objectives requires coordination, information exchange, and shared commitment among the parties involved.

This finding is consistent with previous research indicating that GSCM implementation in construction requires integration among different stakeholders rather than focusing solely on individual organizational practices. Wiguna et al. emphasized that green supply chain practices in the Indonesian construction sector involve various stakeholders and that the development of an effective GSCM framework requires coordination among these parties.

The second-ranked criterion is Green Construction (GC)**,** with a weight of **20.81%**, followed closely by Green Procurement (GP) at **20.73%**. The relatively similar weights of these two criteria indicate that environmental considerations during construction and procurement are both considered highly important. Green construction is directly related to efficient material utilization, resource and energy conservation, and the adoption of environmentally friendly construction technologies. Meanwhile, green procurement determines whether environmentally preferable materials and suppliers are incorporated into the project supply chain from the beginning.

Recent research on sustainable construction materials also demonstrates the importance of systematically prioritizing environmental and technical criteria when selecting construction materials. An AHP-based study published in 2024 identified and prioritized critical criteria for sustainable construction material selection, demonstrating the applicability of hierarchical decision-making to complex material-related sustainability decisions.

Waste Management (ML) has a priority weight of **18.54%**, placing it fourth. Although its weight is lower than the three criteria above, waste management remains an important component of the green material supply chain because material waste can occur during procurement, transportation, storage, and construction activities. The result is consistent with previous Indonesian construction GSCM research, which identified project-site waste management and reduction of hazardous materials as among the important green practices.

The lowest-ranked main criterion is Green Logistics (GL)**,** with a weight of **18.05%**. This does not mean that green logistics is unimportant; rather, the AHP results indicate that, relative to the other four criteria, experts assigned a lower priority to logistics-related environmental practices. Nevertheless, transportation and material storage remain relevant because they influence fuel consumption, emissions, material damage, and project-site efficiency. Previous research on construction supply chains has also identified logistical and operational performance as important areas requiring further attention in GSCM implementation.

4) Priority of Subcriteria

At the subcriterion level, the highest global priority is Shared Environmental Commitment (KL) under Stakeholder Collaboration, with a global weight of **8.19%**. This is followed by Selection of Environmentally Friendly Suppliers (PS) under Green Procurement, with **8.05%**, and Efficient Use of Concrete Materials (EB) under Green Construction, with **7.66%**.

Table 7. The Rank of Subcriterion

Rank	**Criterion**	**Subcriterion**	**Local Weight**	**Global Weight**
1	Stakeholder Collaboration	Shared Environmental Commitment (KL)	37.46%	**8.19%**
2	Green Procurement	Selection of Environmentally Friendly Suppliers (PS)	38.84%	**8.05%**
3	Green Construction	Efficient Use of Concrete Materials (EB)	36.80%	**7.66%**
4	Stakeholder Collaboration	Information Sharing and Transparency (BI)	33.63%	**7.35%**
5	Green Procurement	Use of Environmentally Friendly Materials (PM)	32.27%	**6.69%**
6	Green Construction	Resource and Energy Conservation (KE)	31.88%	**6.63%**
7	Waste Management	3R Application to Concrete Waste (R3)	35.44%	**6.57%**
8	Green Logistics	Transportation Route Optimization (OR)	36.13%	**6.52%**
9	Green Construction	Environmentally Friendly Technology/Methods (TK)	31.33%	**6.52%**
10	Waste Management	Concrete Debris Recycling (DP)	34.48%	**6.39%**
11	Stakeholder Collaboration	Management Commitment and Policy (KM)	28.91%	**6.32%**
12	Green Procurement	Supplier Track Record Evaluation (ER)	28.90%	**5.99%**

13	Green Logistics	Fleet Emission and Maintenance Management (ME)	32.55%	**5.88%**
14	Green Logistics	Environmentally Friendly Material Storage (PN)	31.32%	**5.65%**
15	Waste Management	Fleet Washout Wastewater Management (AW)	30.07%	**5.58%**

5) Highest-Priority Subcriterion

The highest-ranked subcriterion is Shared Environmental Commitment (KL)**,** with a local weight of **37.46%** and a global weight of **8.19%**. This result is particularly important because it demonstrates that green material supply chain implementation in the Jakarta LRT project is not solely a technical or procurement issue. It also depends on the extent to which project stakeholders share a common commitment to environmental objectives.

The second-highest subcriterion is Selection of Environmentally Friendly Suppliers (PS)**,** with a global weight of **8.05%**. This finding indicates that supplier selection represents a strategic entry point for implementing green material supply chain practices. Environmental considerations can be incorporated into supplier evaluation by considering environmental certifications, environmentally responsible production processes, material characteristics, and supplier environmental performance. Research on construction supplier selection has likewise demonstrated the relevance of environmental and green capability criteria in evaluating construction suppliers.

The third priority is Efficient Use of Concrete Materials (EB)**,** with a global weight of **7.66%**. This result is particularly relevant to infrastructure projects such as LRT construction, where concrete constitutes an important construction material. Improving material efficiency can contribute to waste reduction, resource conservation, and potentially lower environmental impacts throughout the project supply chain.

6) Interpretation of the AHP Findings

The AHP results indicate that Stakeholder Collaboration (KS) is the highest-priority main criterion, with a weight of **21.86%**, followed by Green Construction (GC) at **20.81%** and Green Procurement (GP) at **20.73%**. Waste Management (ML) and Green Logistics (GL) obtained weights of **18.54%** and **18.05%**, respectively. The relatively small differences among the five criteria indicate that green material supply chain performance in the Jakarta LRT project is multidimensional and requires an integrated approach.

At the subcriterion level, the local priorities show that **Environmentally Friendly Supplier Selection (PS)** has the highest local weight within Green Procurement (**38.84%**), followed by **Shared Environmental Commitment (KL)** within Stakeholder Collaboration (**37.46%**) and **Efficient Use of Concrete Materials (EB)** within Green Construction (**36.80%**). These findings emphasize the importance of selecting environmentally responsible suppliers, establishing shared environmental commitments among stakeholders, and improving material efficiency during construction.

The consistency test strengthens the reliability of these findings. The calculated **λmax=5.0759**, **CI=0.0190**, and **CR=0.0169**, with **RI=1.120**. Since the CR value is substantially below the acceptable threshold of **0.10**, the expert judgments are considered consistent and the resulting priority weights are reliable. Overall, the AHP findings suggest that green material supply chain implementation in the Jakarta LRT project should begin with strong stakeholder alignment and environmental commitment, supported by green supplier selection and efficient material utilization. These priorities provide a practical basis for project managers to formulate green procurement policies, strengthen collaboration among supply chain actors, improve construction material efficiency, and integrate environmental considerations into logistics and waste management.

4. CONCLUSION

This study demonstrates that the Analytical Hierarchy Process (AHP) can provide a structured basis for prioritizing green material supply chain practices in the Jakarta Light Rail Transit (LRT) project. Among the five main criteria, Stakeholder Collaboration achieved the highest priority weight (21.86%), followed by Green Construction (20.81%) and Green Procurement (20.73%). These findings highlight the importance of integrating environmental objectives into project coordination, construction operations, and material procurement rather than addressing sustainability through isolated activities. The consistency ratio of 0.0169 also indicates that the pairwise comparison judgments satisfy the AHP consistency requirement.

In the context of Jakarta's urban rail infrastructure development, the findings provide practical guidance for strengthening environmental performance throughout the construction supply chain. Project owners, contractors, consultants, and material suppliers can use the priority framework to improve supplier selection, promote efficient use of construction materials, encourage concrete waste recycling, and reduce the environmental impacts of material transportation and storage. Such measures can support more responsible resource utilization and contribute to sustainable infrastructure development in densely populated urban areas.

The implications extend beyond Jakarta to the development of LRT and other urban rail transportation systems across Indonesia. As cities increasingly invest in mass transit to improve mobility and reduce dependence on private vehicles, sustainability considerations should be incorporated from the planning and procurement stages through construction and material

delivery. The proposed AHP framework offers a reference for infrastructure stakeholders to establish project-specific environmental priorities, while recognizing that local material availability, construction conditions, logistics networks, and institutional capacity may differ between regions.

Nevertheless, the study's findings are based on the Jakarta LRT project and should not automatically be generalized to every Indonesian infrastructure project. Further research should validate the criteria and priority weights in other urban rail developments and assess their relationship with measurable environmental indicators, including material consumption, construction waste generation, transport emissions, and recycled material utilization. This would help transform the proposed prioritization framework into a broader decision-support tool for advancing environmentally responsible and sustainable rail infrastructure development throughout Indonesia.

REFERENCES

1) Adhi, A. B., & Muslim, F. (2023). Development of stakeholder engagement strategies to improve sustainable construction implementation based on lean construction principles in Indonesia. Sustainability, 15(7), 6053. https://doi.org/10.3390/su15076053
2) Durgam, H. K. R., & Ramani, P. V. (2025). Green construction supply chain: Reviewing advancements, obstacles, and possibilities. Cleaner Logistics and Supply Chain, 17, Article 100259. https://doi.org/10.1016/j.clscn.2025.100259
3) Mojumder, A., & Singh, A. (2021). An exploratory study of the adaptation of green supply chain management in construction industry: The case of Indian construction companies. Journal of Cleaner Production, 295, Article 126400. https://doi.org/10.1016/j.jclepro.2021.126400
4) Qian, J., Siriwardana, C., & Shahzad, W. (2024). Identifying critical criteria on assessment of sustainable materials for construction projects in New Zealand through the analytic hierarchy process (AHP) approach. Buildings, 14(12), Article 3854. https://doi.org/10.3390/buildings14123854
5) Wiguna, I. P. A., Rachmawati, F., Rohman, M. A., & Setyaning, L. B. (2021). A framework for green supply chain management in the construction sector: A case study in Indonesia. Journal of Industrial Engineering and Management, 14(4), 788–807. https://doi.org/10.3926/jiem.3465