Designing and Evaluating Criteria for Sustainable Supply Chain at PT. Panca Putra Galvalume Steel Kediri

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ABSTRACT

Achieving sustainability in transportation and supply chains is critical in today's competitive, environmentally conscious world. This study focuses on prioritizing factors for a sustainable Galvalume steel supply chain in Indonesia, emphasizing material availability, efficient logistics, and eco-friendly practices. A new method utilizing the Analytic Hierarchy Process (AHP) is proposed to address the balance between economic efficiency and environmental responsibility. Six criteria were identified: material availability (X_1), transport choice (X_2), cost-effective packaging (X_3), customer service (X_4), profit optimization (X_5), and environmental safety (X_6). Results indicate that material availability (X_1) is the top priority, followed by cost-effective packaging (X_3) and environmental safety (X_6). The study highlights the importance of consistent decision-making in sustainable supply chain management and identifies opportunities for incorporating electric vehicles and greener transport methods in future research. Overall, this research provides actionable insights for optimizing Galvalume steel supply chains with minimal environmental impact.

1. INTRODUCTION

In this era of globalization, the manufacturing industry is faced with various challenges, including fierce competition, increasingly high consumer demands, and awareness of environmental sustainability (Chen, 2021). In this context, companies must be able to adapt and innovate to achieve long-term competitive advantage and sustainability. In the era of sustainability, companies that succeed in being competitive in the market must pay attention to product sustainability aspects throughout the logistics and supply chain processes (Díaz-Reza et al., 2024). PT. Panca Putra Galvalume Steel Kediri, as one of the leading galvalume suppliers in Indonesia, it is one of the leading galvalume suppliers in Indonesia, it is one of the companies that develops sustainability strategies in

logistics and supply chains (Sarjono et al., 2022). With innovation and technology development, PT. Panca Putra Galvalume Steel Kediri creates galvalume that is more economical, efficient, and environmentally friendly (Dlimi et al., 2023; Fu et al., 2023).

This research has a fairly high urgency, especially in the era of sustainability and environmental resilience. With the rapid development of technology and globalization, transportation has become one of the main aspects of business and the economy. However, transportation also has negative impacts on the environment, such as air pollution, fossil fuel use, and pollution (Costa et al., 2015; Khatun et al., 2023; Ren et al., 2023). At the same time, consumers increasingly want products and services that are more efficient, economical, and environmentally friendly (Mohsen, 2023). This makes transportation a top priority in the company to increase competitiveness and reduce operational costs (Dlimi et al., 2023; Handayani et al., 2019; Korpysa & Halicki, 2022). Consumers increasingly want products and services that are more efficient and environmentally friendly. This makes transportation a top priority in the company to increase competitiveness and reduce operational costs.

The research identifies six critical factors for sustainable transport systems, prioritized based on their relative importance, and recommends specific strategies to address them (Achetoui et al., 2019). These factors are: (1) ensuring the availability of materials, (2) implementing reverse logistics, (3) adopting third-party logistics services, (4) implementing environmentally friendly packaging practices, (5) maximizing profits, and (6) ensuring the living environment. Security. The study's findings have significant implications for businesses operating in different geographic locations as they strive to be sustainable and environmentally responsible. By implementing this strategy, businesses can reduce costs, increase competitiveness, and contribute to a cleaner, healthier environment in their respective locations. This study also conducts an Analytical Hierarchy Process (AHP) analysis to determine the priority of these factors. AHP analysis involves a pairwise comparison of those factors using a nine-point scale to determine their relative importance. The results are then used to calculate the weight of each factor based on its importance. AHP analysis also includes the calculation of the consistency ratio (CR) to determine whether or not the model is consistent. CR values less than 0.1 indicate consistency, while values greater than 0.1 indicate inconsistency. In this study, the entire CR value was less than 0.1, indicating consistency in the model.

The materials industry is a major contributor to Indonesia's GDP, with SMEs playing a big role. Studies have explored various aspects of supply chain performance, resilience, and sustainability in the textile and garment industry. However, there are challenges such as weighting bias towards economic factors in supplier selection and a lack of support for sustainable practices.

This study prioritizes criteria for a sustainable Galvalume steel supply chain in Kediri, Indonesia. Key factors include material availability, transportation efficiency, cost-effective packaging, and environmental safety. The findings can improve logistics and supply chain management for PT. Panca Putra Galvalume Steel Kediri. The research proposes a novel approach to prioritizing sustainability criteria for Galvalume products in logistics and supply chains by combining the Analytical Hierarchy Process (AHP) with weight and rank allocation for six main criteria and their sub-criteria. The method emphasizes material availability, followed by cost-effective packaging and decision-making consistency. This framework can benefit companies aiming to adopt sustainable logistics practices by integrating well-established methods (such as material availability and efficient transportation) with innovative practices (such as eco-friendly packaging and supplier audits) to optimize logistics, reduce environmental impact, and maximize profitability.

The novelty of this approach lies in the development of a sustainability prioritization method specifically applied to the Galvalume product supply chain in Indonesia, which has not been extensively studied in the context of the local building materials industry. The approach utilizes an expanded AHP method with weight and rank allocation for six main criteria and their sub-criteria, adapted to the local characteristics of the Galvalume industry in Kediri through literature review, expert interviews, and stakeholder input. The combination of conventional practices, such as material availability and transportation efficiency, with innovative elements like supplier audits and eco-friendly packaging, makes this approach unique and applicable in promoting sustainable logistics strategies in a sector that has received limited attention. Although Indonesia's textile and building materials industries—largely dominated by SMEs—have been widely researched in terms of supply chain performance, resilience, and sustainability, several challenges remain, particularly in balancing economic considerations with environmentally friendly supplier selection and the lack of support for circular practices. Therefore, the findings of this study offer a new solution for sustainable logistics and supply chain management at PT. Panca Putra Galvalume Steel Kediri by integrating transportation efficiency and eco-friendly packaging practices, which are rarely implemented in the building materials industry.

This research aims to develop and prioritize criteria in building a sustainable Galvalume steel supply chain in Kediri, Indonesia, especially at PT. Panca Putra of Galvalume Steel Kediri. This research not only focuses on the selection and ranking of criteria, but also includes the process of identifying and excavating the criteria initially through a literature review, interviews with experts, and input from relevant stakeholders. Furthermore, the resulting criteria will be adjusted to the local context and characteristics of the Galvalume steel industry, and then analyzed the level of importance using the appropriate multicriteria decision-making method. The results of this research are expected to be the basis for designing a more sustainable supply chain strategy that is in line with economic, social, and environmental principles.

The research addresses the growing need for sustainable practices in the manufacturing industry, particularly within the Galvalume steel supply chain. It acknowledges the dominance of SMEs in Indonesia's

materials industry and the importance of this sector to the country's GDP.

The study highlights existing challenges in achieving sustainable supply chains, such as a Bias towards economic factors when selecting suppliers and a Lack of support for implementing sustainable practices. To address these gaps, the research proposes a novel approach using the Analytic Hierarchy Process (AHP) to prioritize six critical criteria for sustainable Galvalume product logistics and supply chains. This study adopted six sustainability criteria from (Achetoui et al., 2019): material availability, reverse logistics, third-party logistics, eco-friendly packaging, profit maximization, and environmental safety. These formed the foundation of the analytical framework. Additional criteria transportation efficiency, cost-effective packaging, and customer service, were developed based on the local context of the Galvalume industry in Kediri and stakeholder input. This combination ensures a more contextual and practical approach to sustainability prioritization.

It establishes a novel framework using AHP to prioritize sustainability criteria in Galvalume product logistics. The framework combines well-established practices like ensuring material availability and efficient transportation with innovative practices like implementing eco-friendly packaging and conducting supplier audits. By prioritizing these criteria, companies like PT. Panca Putra Galvalume Steel Kediri can optimize its logistics operations, minimize environmental impact, and achieve greater profitability through sustainable practices. The research findings can be valuable for Galvalume steel suppliers and other companies in Indonesia and beyond, guiding them towards more sustainable logistics and supply chain management.

2. LITERATURE REVIEW

Indonesia's textile industry, contributing around 7% to national GDP, is largely driven by SMEs, particularly in the garment sector. (Yanti & Maghfiroh, 2022) Evaluated SME supply chain performance using the SCOR model, finding generally strong outcomes. Various studies emphasize resilience and sustainability in supply chains: (Liu et al., 2023) Highlight post-pandemic adaptability through collaboration; (Marzouk & Sabbah, 2021) Use AHP-TOPSIS to assess social sustainability in supplier selection; and (Chi & Chien, 2023) Demonstrate enhanced decision-making with fuzzy AHP. (Mola-Yudego et al., 2024) Found that environmental concerns dominate expert priorities in biomass supply chains. In logistics, (Mohsen, 2023) identified special services and proven experience as key criteria for provider selection, while (Komal & Saad, 2024) Emphasized supplier development and procurement in the UK textile digitalization. (Potticary et al., 2024) and (Saad et al., 2024) Further reinforced the roles of forecasting, lead time, and Industry 4.0 in improving SME service chains.

Advanced decision models such as AHP, Delphi, GP, and DEMATEL are increasingly applied in supplier evaluation and resource allocation (Dožić et al., 2023; Khorramshahgol & Al-Husain, 2021; Gökler & Boran, 2023). In reverse logistics, AHP-TOPSIS helps identify optimal IoT tracking systems (Badulescu et al., 2022), while (Lahane & Kant, 2021) Noted supply-demand imbalance and management support as major COVID-19 challenges. (Menon & Ravi, 2022) proposed a four-dimensional supplier model integrating ethics with the Triple Bottom Line, supported by (Kafle et al., 2023; Runtuk & Maukar, 2019) Who evaluated 16 sustainability sub-criteria? Despite a bias toward economic factors, ethical elements like human rights remain critical (Ramayanti & Ulum, 2017). Domestically, green furniture supply chains, reverse logistics risks in FMCG (Ramadhanti & Pulansari, 2022; Yuliawati & Brilliana, 2022), and algorithmic optimization in routing (Maghfiroh & Redi, 2022; Purnomo, 2023) Reflect growing strategic attention to efficiency and sustainability across Indonesian industries.

3. METHODS

This study uses a mixed-method approach that combines qualitative and quantitative methods to understand sustainability criteria in the Galvalume steel supply chain. A qualitative approach is conducted through interviews with operational managers, industry experts, and stakeholders to generate and verify initial criteria based on the local context. Furthermore, a quantitative approach is applied with the Analytical Hierarchy Process (AHP) method to prioritize criteria based on their level of importance. The AHP provides systematic weighting, and the validity of the results is assessed through a consistency index (CI) that must be below 0.1 to ensure the reliability of respondents' assessments. The combination of these two approaches provides a strategic and practical basis for PT. Panca Putra Galvalume Steel Kediri is developing a sustainability strategy. Companies can focus more on allocating resources, establishing sustainable operational and procurement policies, and strengthening long-term competitiveness based on data and relevant to real-world conditions.(Lahane et al., 2023; Menon & Ravi, 2022; Mohsen, 2023).

The study population used officials who were in PT. Panca Putra Galvalume Steel Kediri. The sample size uses a saturated sample because it takes 3 officials involved in the upstream to downstream process, including a general manager of 1 person, a quality control team of 1 person, and a supply chain team of 1 person.

Observation activities by coming to the location of PT. Panca Putra Galvalume Steel Kediri from September 10, 2023, to November 10, 2023. This observation activity was also conducted by conducting interviews with 3 selected respondents. Interviews were conducted by identifying the importance of influence of material availability (X_1), choice of transportation mode (X_2), cost-efficient and robust packing (X_3), customer service (X_4), optimizing profits (X_5), and Attention to the safe environment (X_6) as shown in Table 1. This study used an *Analytical Hierarchy Process* questionnaire with paired comparison criteria of 5 attributes with sub-attributes in this study. The questionnaire result processing tool uses Microsoft Excel, which has been modified with the right *Analytical Hierarchy Process* stages.
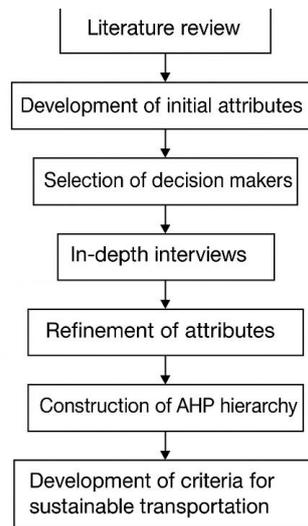
Figure 1. Conceptual Framework

Table 1. Operational Variable

No	Atribute	Sub- Attribute	Evaluation Criteria	Source
1	Material availability (X_1)	1. Galvalume material consumption efficiency 2. Investment renewal of material excess 3. Sale of waste materials	Stable and efficient material availability has a significant impact on the sustainability of the galvalume steel supply chain.	(Xiao et al., 2023) (Menon & Ravi, 2022) (Komari, 2021; Prasetyo et al., 2020; Rossi et al., 2022)
2	Choice of mode of transport (X_2)	4. Efficiency of material arrival routes 5. Reverse logistic 6. Adoption of third-party logistics	The selection of efficient and sustainable modes of transportation has a significant impact on the smoothness and effectiveness of the galvalum steel supply chain.	(Mavi, 2017) (de Souza et al., 2022; Giusti et al., 2019)
3	Packing Cost-Efficient and Sturdy (X_3)	7. Reduce packaging 8. Degradable, eco-friendly 9. Eco-labeling products	Efficient, environmentally friendly, and standardized packaging contributes to waste reduction and supports supply chain sustainability.	(Balwada et al., 2021; de Souza et al., 2022; Nandakumar et al., 2020) (Hou et al., 2023; Laso et al., 2017)
4	Customer service (X_4)	10. ISO 9001 Certification 11. Time to market 12. Product quality supports environmental regulations	Superior customer service through quality certification, distribution speed, and environmental compliance strengthens the competitiveness and sustainability of the supply chain.	(Metasari, 2014; Prihatmadji, 2019) (Ellram & Murfield, 2019; Komari et al., 2021, 2020)
5	Optimizing Profits (X_5)	13. Long-term profitability 14. Reduce operational costs 15. Building a waste material recycling system	Optimizing profits through cost efficiency, long-term strategies, and waste recycling systems supports the sustainability of supply chain operations.	(Buavaraporn, 2010; Gaganis et al., 2019; Obal & Gao, 2020) (Loizia et al., 2021)
6	Safe environmental attention (X_6)	16. Create a production capacity maintenance table 17. Audit of suppliers' internal management 18. Establish an environmental pollution prevention program	Attention to the environment through production maintenance, supplier audits, and pollution prevention supports sustainable supply chain practices.	(Azadnia et al., 2023; Gökler & Boran, 2023; McBrien et al., 2016) (Achmad et al., 2023; Mugoni et al., 2024; Truant et al., 2024)

Table 2. AHP Assessment Scale

Level of importance	Information
9	Absolutely more influential
7	Very much more influential
5	More influential
3	A little more influential
1	Equally influential
2, 4, 6, 8	Values include

AHP uses a decision model with the following stages (Handayani et al., 2019):
1. Defining problems and goals
2. Compile a hierarchy of the problems taken. The problems are arranged in a hierarchy with general objectives, then continued sub-objectives, criteria, and possible alternatives at each level of the lowest criteria.
3. Create a pairwise comparison matrix with weightings, use arbitrary weights, create an interval scale with the order of each criterion, or use paired comparisons so that the importance of alternatives to the criteria is clearly stated, as shown in Table 2.

Comparison uses the judgment of decision makers by assessing the importance of elements. The comparison matrix is as follows:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & a_{m} \end{bmatrix} \quad (1)$$

Calculates geometric averages to be used to make decisions. The geometric mean is used to get stump results from several respondents. The geometric mean formula is:

$$f(x_1, x_2, \dots x_n) = x_1^{q1} x_2^{q2} \dots x_n^{qn} \quad (2)$$

Information:
$f(x)$ = Average – Geometric Flat
x_n = The value each respondent gave in the comparison
q_n = respons weight

This process generates weight towards the achievement of goals. The value of the eigenvector for the priority weight of the matrix in composing the super matrix. Thus, normalization is used to sum elements in one column with formulas:

$$Z_j = \sum_{i=1}^{n} a_{ij}, \text{ for } j = 1, 2, \dots, n \quad (3)$$

Information:
Z_j = number of elements in the *j-th* column
The elements in the matrix are divided by, to get normalization. Then find the vector weight with the average using the formula:

$$w_i = \frac{\sum_{j=1}^{n} \frac{a_{ij}}{z_j}}{n}, \text{ for } i = 1, 2, \dots, n \quad (4)$$

If the compensating comparison is complete, then the eigen vector is searched by the formula:

$A \cdot w = \lambda_{maks} \cdot w$
Information:
A = Pairwise comparison matrix
λ_{maks} = largest eigenvector of A

Calculating the consistency ratio by looking at the consistency value to some degree of 10% or less is still allowed. Possible deviations from pairwise comparisons due to inconsistencies in preferences. The consistency ratio assigns a numerical value to the achievement of the consistency index using the formula:

$$CI = \frac{\lambda_{maks} - n}{n - 1} \quad (5)$$

Information:
N = matrix size or number of items being compared
When CI is 0, it is expressed as a consistent matrix. Inconsistent limits use consistency ratio (CR) or comparison of consistency index with random index (RI) with the formula:

$$CR = \frac{CI}{RI} \quad (6)$$

The results of the AHP (Analytic Hierarchy Process) in this case are used to assess the consistency of judgments made during the pairwise comparisons for evaluating the sustainability of Galvalume products at PT. Panca Putra Galvalume Steel Kediri in logistics and the competitive supply chain.

4. RESULTS AND DISCUSSIONS

A prioritization of sustainability criteria for Galvalume products at PT. Panca Putra Galvalume Steel Kediri in logistics and the competitive supply chain is presented in the following table. The table details six crucial criteria (K1-K6) along with their assigned weights (Weight) and corresponding ranks (Rank), indicating their relative importance. Each criterion is further broken down into sub-criteria (Subcriteria) with their own partial weights (Partial Weight). The global weight (Global Weight) for each sub-criterion is calculated by multiplying its partial weight by the weight of its corresponding main criterion (Table 3).

The six criteria (K1-K6) with weight (Weight) and order (Rank) are based on their priority. Each criterion results from a sub-criterion (Subcriteria) with a partial weight (Partial Weight) assigned to it. The global weight (Global Weight) for each sub-criterion is calculated by multiplying its partial weight by the weight of the corresponding criterion, as shown in Table 3.

The first criterion, Material availability (X_1), weights 0.3231 and is ranked first. It is divided into three sub-criteria: Efficiency of galvalume material consumption, Investment renewal of material loss, and Sales of waste material in the form of waste. The partial weights assigned to these sub-criteria are 0.3810, 0.3131, and 0.3059, resulting in global weights of 0.1231, 0.1012, and 0.0988 for each sub-criterion.

The second criterion, Choice of mode of transport (X_2), weights 0.2586 and is ranked second. It is divided into two sub-criteria: Material arrival route efficiency and Reverse logistics, with partial weights of 0.5266 and 0.2728, respectively, resulting in global weights of 0.1362 and 0.0705 for each sub-criterion. The third sub-criterion, Adoption of third-party logistics, has a partial weight of

Table 1. Global Weight

Criterion	Weight	Rank	Subcriteria	Partial Weight	Global Weight
Material availability (X_1)	0.3231	1	Galvalume material consumption efficiency	0.3810	0.1231
			Investment renewal of material excess	0.3131	0.1012
			Sale of waste materials	0.3059	0.0988
Choice of mode of transport (X_2)	0.2586	2	Efficiency of material arrival routes	0.5266	0.1362
			Reverse logistic	0.2728	0.0705
			Adopsi third-party-logistic	0.2006	0.0519
Packing Cost-Efficient and Sturdy (X_3)	0.1403	3	Reduce packaging	0.4814	0.0675
			Degradable eco-friendly	0.3295	0.0462
			Eco-labeling products	0.1891	0.0265
Customer service (X_4)	0.1184	4	ISO 9001 Certification	0.5853	0.0693
			Time to market	0.2941	0.0348
			Product quality supports environmental regulations	0.1205	0.0143
Optimizing Profits (X_5)	0.1033	5	Long-term profitability	0.3722	0.0385
			Reduce operational costs	0.3847	0.0398
			Building a waste material recycling system	0.2430	0.0251
Safe environmental attention (X_6)	0.0563	6	Create a production capacity maintenance table	0.7353	0.0414
			Audit of suppliers' internal management	0.3483	0.0196
			Establish an environmental pollution prevention program	0.1688	0.0095

0.2006 and a global weight of 0.0519.

The third criterion, Packing Cost-Efficient and Sturdy (X_3), weights 0.1403 and is ranked third. It is divided into three sub-criteria: Reduce packaging, Eco-friendly Degradable, and Eco-labeling products, with partial weights of 0.4814, 0.3295, and 0.1891, respectively, resulting in global weights of 0.0675, 0.0462, and 0.0265 for each sub-criterion.

The fourth criterion, Customer service (X_4), has a weighting of 0.1184 and is ranked fourth. It is divided into three sub-criteria: ISO 9001 certification, Time to market, and Product quality supporting environmental regulations, with partial weights of 0.5853, 0.2941, and 0.1205, respectively, resulting in global weights of 0.0693, 0.0348, and 0.0143 for each sub-criterion.

The fifth criterion, Optimizing Profits (X_5), weights 0.1033 and is ranked fifth. It is divided into three sub-criteria: ;ong-term profitability, reducing operational costs, and building a waste material recycling system, with partial weights of 0.3722, 0.3847, and 0.2430, respectively, resulting in global weights of 0.0385, 0.0398, and 0.0251 for each sub-criterion.

The environmental safety criteria (X_6) weigh 0.0563 and are ranked last. It is divided into three sub-criteria: Creating production capacity maintenance tables, auditing suppliers' internal management, and establishing environmental pollution prevention programs, with partial weights of 0.7353, 0.3483, and 0.1688, respectively, resulting in a global weight of 0.0414.

Competitive logistics and supply chains require material availability, cost efficiency, and good customer service. By carrying out these implementations, PT. Panca Putra Galvalume Steel Kediri can improve its overall logistics and supply chain management. This will have a positive impact on company performance, such as increasing profitability, competitiveness, and customer satisfaction.

The Consistency Ratio (CR) and Consistency Index (CI) are used to evaluate the consistency of pairwise comparisons made by decision-makers in the AHP method. The CI is calculated by subtracting the number of criteria from the maximum eigenvalue (λ_{max}), then dividing the result by the number of criteria minus one. The CR is then obtained by dividing the CI by the corresponding Random Index (RI) value based on the number of criteria, and it is compared to a threshold value of 0.1. If the CR is less than 0.1 (CR < 0.1), the comparisons are considered consistent. Conversely, if the CR is equal to or greater than 0.1 (CR ≥ 0.1), the comparisons are deemed inconsistent and require revision. As shown in Table 4, only the criteria for Customer Service (X_4) and Optimizing Profits (X_5) exceed the threshold value, indicating a need for reevaluation to ensure the validity of the analysis results as shown in Table 4.

The sustainability of the galvalume steel supply chain is influenced by six interrelated key factors. Stable and efficient material availability (X_1), achieved through galvalume consumption efficiency, investment in managing excess materials, and the sale of waste materials, forms the foundation for continuous production. The choice of transport mode (X_2), involving efficient delivery routes, the implementation of reverse logistics, and the adoption of third-party logistics, plays a vital role in ensuring smooth and effective material distribution. Additionally, cost-efficient, environmentally friendly, and standardized packaging (X_3) supports waste reduction and enhances operational sustainability. In terms of customer service (X_4), quality certification, speed to market, and compliance with environmental regulations enhance competitiveness while reinforcing supply chain integrity. Profit optimization (X_5), through

Table 2. Ratio, Consistency, and Criteria Rank

Variables	Sigma VB	Lambda max	CI	CR<0.1	Decision
Availability of material (X_1)	9.002	3.001	0.000	0.001	Consistent
Choice of mode of transport (X_2)	9.133	3.044	0.022	0.043	Consistent
Packing Cost-Efficient and Sturdy (X_3)	9.034	3.011	0.006	0.011	Consistent
Customer service (X_4)	9.034	3.220	0.110	0.212	Inconsistent
Optimizing Profits (X_5)	9.627	3.209	0.105	0.201	Inconsistent
Safe environmental attention (X_6)	9.009	3.003	0.002	0.003	Consistent

long-term strategic planning, operational cost reduction, and the development of waste recycling systems, is essential to sustaining business operations. Lastly, environmental attention (X_6), realized through production capacity maintenance, supplier audits, and pollution prevention programs, reflects a strong commitment to responsible and sustainable industrial practices.

In this case, all CI values are less than 0.1, indicating that the pairwise comparison is consistent. The CR value is also less than 0.1, which is below the threshold value, indicating that the AHP model is consistent and reliable.

The rankings obtained from this analysis can be used to prioritize criteria based on their relative importance in achieving a sustainable transportation system. In this case, material availability (X_1) holds the highest priority, followed by cost-efficient and sturdy packing (X_3), choice of transportation mode (X_2), optimizing profits (X_5), safe environmental attention (X_6), and customer service (X_4) with the lowest rating. This indicates that ensuring the availability of materials should be the foremost focus in developing sustainable transportation systems, followed by implementing efficient and eco-friendly packaging, selecting appropriate transportation modes, enhancing profitability, addressing environmental concerns, and improving customer service.

To guarantee material availability (X_1), a strategic approach consisting of three main points must be applied. First, galvalume (E1) consumption efficiency must be maximized through proper inventory management, minimizing waste, and optimizing production processes. Secondly, investments in galvalume should be updated based on their advantages, such as durability and low maintenance costs, which will result in a higher return on investment (R1). Lastly, the sale of excess galvalume as scrap material (X_2) should be explored as an additional revenue stream (R2). By implementing this strategy, the availability of galvalume will be increased, resulting in more efficient and profitable operations.

In choosing the most effective mode of transportation (X_2), there are three strategies to consider: the efficiency of material arrival routes (1), return logistics (2), and the adoption of third-party logistics (3). First, optimizing raw material delivery routes can significantly improve efficiency. By analyzing delivery patterns and identifying bottlenecks, companies can develop more efficient routes that minimize transportation time and costs. This strategy is especially useful for industries with multiple suppliers or distribution centers. Second, reverse logistics, also known as closed-loop supply chain management, involves managing the flow of materials from the point of consumption back to the point of origin for reuse, recycling, or disposal(Ul Islam et al., 2022). This strategy reduces waste, saves resources, and lowers costs associated with disposal. This is particularly relevant for industries with high waste generation, such as manufacturing and retail. Third, the implementation of third-party logistics services (3PLs) can provide significant benefits in terms of cost savings, flexibility, and expertise (Lahane et al., 2023). 3PL providers offer a variety of services, including transportation management, warehousing, and fulfillment, that can be customized to meet specific business needs. This strategy is especially useful for small and medium-sized businesses that lack the resources to manage their own logistics operations. The combination of these strategies can help companies optimize their modes of transportation while minimizing costsand impacts on the environment and society (Ayoubi & Radmehr, 2023; Hafezalkotob et al., 2023). By implementing efficient delivery routes, reverse logistics practices, and 3PL services, companies can remain competitive in today's global market.

In today's increasingly environmentally conscious world, businesses are realizing the importance of implementing cost-effective and sustainable packaging strategies. By reducing packaging, using biodegradable, eco-friendly materials, and implementing eco-labeling practices, companies can significantly lower packaging costs while contributing to a healthier environment (Khatun et al., 2023; Mugoni et al., 2024). First, reducing packaging is a simple but effective way to cut costs. By minimizing the amount of material used in packaging, businesses can significantly reduce overall packaging costs (Larrick et al., 2022). This can be achieved by using smaller or compact packaging designs, eliminating unnecessary packaging components, and optimizing space usage during transport (Laso et al., 2017). Second, the use of biodegradable and environmentally friendly materials is another effective strategy for cost-effective and sustainable packaging. These materials are biodegradable, meaning they decompose naturally over time, reducing waste and impact on the environment (Achmad et al., 2023). In addition, biodegradable materials are often cheaper than traditional packaging materials due to their lower production costs. Finally, the adoption of eco-labeling practices is a powerful tool for companies looking to reduce packaging costs while

promoting sustainability (Tălpău, 2014). Eco-labeling involves labeling a product that demonstrates its environmental friendliness or sustainability credentials (Truant et al., 2024). These labels can help consumers make informed purchasing decisions and can also provide a competitive advantage to businesses in the market. In addition, eco-labeling can help companies reduce their overall adverse environmental impact by encouraging them to implement more sustainable practices throughout their supply chain. By implementing these three strategies – reducing packaging, using biodegradable materials, and adopting eco-friendly labeling practices – businesses can significantly lower packaging costs while contributing to a healthier environment. These strategies not only benefit the environment but also provide a competitive advantage to businesses in the market as consumers become increasingly aware of sustainability issues.

At our customer service (X_4), we have designed a strategic approach that includes three key elements to ensure exceptional service. First, we hold the prestigious ISO 9001 certification, demonstrating our commitment to quality management systems and customer satisfaction (Rushanti et al., 2017). Second, we prioritize fast time to market, allowing us to deliver products and services quickly and efficiently (Tiwari et al., 2023; Wang & Hubbard, 2017). Finally, our products are designed to meet environmental regulatory standards, ensuring their quality and reliability while minimizing their impact on the environment. By implementing this strategy, we strive to exceed customer expectations and provide the best service to them.

To maximize profits for X_5, a three-pronged strategy must be implemented in the long run. First, prioritizing long-term profitability involves strategic investments in research and development, as well as expansion into new markets and product lines (Gan et al., 2018; Pylaeva et al., 2022). This will not only increase revenue but also strengthen the company's competitive position. Second, reducing operating costs is critical to maximizing profits. This can be achieved through process simplification, optimization of resource utilization, and implementation of cost-saving measures such as energy-saving technologies and waste management programs (Adeodu et al., 2023; Hidayat et al., 2019). Finally, establishing a sustainable waste management system is essential to minimize environmental impact by reducing waste generation and promoting material recycling. Separately, efforts to optimize profits (X_5) can focus on improving operational efficiency, such as cost control, investment planning, and long-term profitability strategies. By addressing environmental and economic goals through distinct yet complementary approaches, each criterion remains analytically independent and aligned with the overall sustainability objectives. This strategy is also in line with the increasing consumer demand for environmentally responsible products and companies.

In today's world, environmental safety has become a top priority for businesses in various industries. To ensure a safe and healthy environment, Safe Environmental Concerns (X_6) has designed a strategic approach that includes three important steps. First, we will apply the table for the maintenance of production capacity

(Handayani et al., 2019). These tables will help us monitor the condition of our equipment and machinery, allowing us to identify potential problems before they become major problems. By performing regular maintenance, we are able to prevent damage and minimize the environmental impact of our operations. Second, we will conduct an internal audit of our supplier management practices. This audit will allow us to evaluate our suppliers' environmental policies and practices and identify areas where they can improve their sustainability efforts (Al-Shboul et al., 2018; Rekik, 2011). By working closely with suppliers, we can encourage environmentally responsible practices throughout our supply chain. Finally, we will establish a program to prevent environmental pollution. The program will involve regular monitoring of our operations to identify potential sources of pollution and implement measures to mitigate them. We will also train our employees on environmental best practices to ensure that they are aware of their role in protecting the environment. By implementing this strategy, Safe Environmental Attention (X_6) is committed to minimizing environmental impact and driving sustainable practices across our operations.

The importance of sustainable transportation in the Galvalume supply chain in Kediri, East Java. Appropriate vehicle dimensions must consider capacity (5-30 tons), efficiency (fuel consumption and exhaust emissions), and suitability for road infrastructure in Indonesia. Standard trucks such as Engkel (5-7 tons), Tronton (15-20 tons), and trailers (20-30 tons) are potentially suitable for the Kediri area. Towed trucks and electric vehicles could become more efficient and environmentally friendly alternatives in the future, taking into account infrastructure availability.

These strategies focus on material availability, efficient transportation, cost-effective packaging, exceptional customer service, profit maximization, and environmental safety. Implementing these strategies can enhance overall logistics, supply chain management, and company performance.

5. CONCLUSIONS

This research highlights key criteria for building a sustainable Galvalume supply chain. The availability of raw materials (X_1) emerged as the most critical factor, achieving the highest ranking with perfect consistency (CI=0.000) and a strong ratio (9.002). Other important criteria include cost-efficient and sturdy packaging (X_3) with high consistency (CI=0.006, Ratio=9.034) and environmental safety (X_6) with a notable consistency index (CI=0.002, Ratio=9.009). These findings emphasize the need for eco-friendly and cost-effective practices in supply chain operations. Conversely, customer service (X_4) and profit optimization (X_5) showed higher inconsistency (CI > 0.1), indicating a need for further refinement in their prioritization.

The study also underscores the importance of implementing best practices throughout the supply chain, particularly in the selection of modes of transport, packaging efficiency, and environmental management. This study shows that the availability of raw materials is

the most crucial factor in building a sustainable Galvalume supply chain, followed by packaging efficiency and environmental safety, as evidenced by consistent and valid AHP results. Meanwhile, aspects such as customer service and profit optimization show a high level of inconsistency in respondents' assessments, which indicates the need for further study. Although modes of transportation do not emerge as a top priority quantitatively, the importance of efficient and environmentally friendly transportation practices remains relevant, especially in the context of industry trends and operational needs on the ground. Therefore, the implementation of best practices such as choosing the right mode of transportation, effective packaging, and prudent environmental management remains an important focus in supply chain strategies. In addition, future development opportunities, including the integration of electric vehicles and articulated trucks, could support the transition to a greener and more efficient logistics system.

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