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MODELING OF SUPPLIER SELECTION STRATEGY AND RAW MATERIAL ORDER ALLOCATION WITH ANALYTIC HIERARCHY PROCESS APPROACH AND LINEAR PROGRAMMING AT PT. IKSG

Ahmad Zulaihan*, Nurhadi Siswanto
Institut Teknologi Sepuluh November, Surabaya, Indonesia
Email: ahmad.zulaihan@gmail.com

ABSTRACT

The dynamics and challenges of the business environment require companies to adapt quickly and responsively to changes. The ability to meet customer expectations through quality products and services at competitive prices is the key to the company's sustainability. A reliable supply chain plays an important role in this matter, not only ensuring economic efficiency, but also paying attention to social and environmental aspects. Trusted suppliers are the main support to ensure the availability of quality raw materials, competitive costs, and are supported by good after-sales service. This research aims to develop an integrated model to overcome the problem of supplier selection and raw material order allocation at PT. IKSG. The model combines the Analytic Hierarchy Process (AHP) and Linear Programming approaches. AHP is used to objectively evaluate and determine the best supplier selection, while Linear Programming allocates the optimal order quantity to each of the selected suppliers. The study's results successfully identified the criteria for selecting suppliers that support the concept of sustainability. The three main criteria obtained were economic (weight 63.16%), environment (weight 26.67%), and social (weight 10.17%). Economic criteria have subcriteria of quality, cost, availability, flexibility, delivery, and finance. Environmental criteria have subcriteria for waste management, reputation, and environment-related certificates. Social criteria have subcriteria for the rights of employees, working hours, and worker safety. From the evaluation of six alternative suppliers, the three best suppliers were selected. The optimal allocation of raw material orders is allocated to SDP (S1), PT (S5) and SCG (S6) in order.

KEYWORDS *Supplier Selection, Supply Chain, Analytic Hierarchy Process, Linear Programming, Packaging Industry.*

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INTRODUCTION

Increasingly fierce business competition requires companies to constantly adapt and improve performance. One of the important aspects in achieving competitive advantage is effective supply chain management (Watanabe, 2001). Choosing the right supplier is the key to success in managing the supply chain, as suppliers play an important role in providing quality, timely and competitively priced raw materials.

PT IKSG, a national company engaged in the production of packaging made of kraft paper and polypropylene plastic ore, faces challenges in selecting polypropylene raw material suppliers. Increased production capacity and increasingly fierce competition demand a better supplier selection system. Currently, the supplier selection method used by companies still has some weaknesses, such as lack of consideration for sustainability aspects and lack of ability to ensure the availability of raw material supply, especially for polypropylene. The use of simple and less comprehensive methods in evaluating suppliers leads to instability in the supply of raw materials and has an impact on the company's performance. Therefore, improvements need to be made in the supplier selection process to overcome these problems.

Polypropylene is commonly called polypropylene (PP) composed of a group of monomers in the form of compounds that have a structure (CH2=CH-CH3). Polypropylene composed of a group of monomers is arranged through a general additive polymerization process (Sperling, 2001). Polypropylene has become a top choice in the packaging industry, especially for the production of woven sack packaging. PP's superior properties such as high strength, chemical resistance, and light weight make it ideal for a wide range of applications. The production process of woven sacks from PP involves several stages, ranging from mixing raw materials, extrusion, winding, coating, printing to conversion into sacks. Woven sacks have a variety of uses, including in the cement, agriculture, and chemical industries.

The company has implemented a structured procurement system with the principles of transparency, accountability, and efficiency. The procurement process consists of several stages, ranging from the request for goods/services by users, technical evaluation to delivery and handover of goods. However, the evaluation of suppliers currently still uses limited criteria and is not fully effective in ensuring stable supply availability. The selection of polypropylene suppliers is a very important strategic decision for the company. The right selection criteria will ensure the availability of quality raw materials and support smooth production.

This research aims to develop a more comprehensive and sustainable supplier selection model for companies. This model will combine the Analytic Hierarchy Process (AHP) and Linear Programming methods. AHP is used to determine the relative weights of various supplier selection criteria, while Linear Programming is used to optimize order allocation to selected suppliers.

Much research has been done on supplier selection. Supplier evaluation and selection is a complex multi-criteria decision-making problem, involving qualitative and quantitative factors (Schramm, Cabral and Schramm, 2020). The right approach to solve this problem is to use the Analytic Hierarchy Process method (Ishizaka and Labib, 2009; Lima Junior, Osiro and Carpinetti, 2014). Supplier selection is a strategic decision that requires careful evaluation (Ghadimi, Ghassemi Toosi and Heavey, 2018). So this strategy is expected to be able to ensure excellence in the supply chain by establishing cooperation and getting support from trusted suppliers. Supplier identification is crucial and at least identifies two main aspects in supplier selection, namely the determination of criteria and ranking methods (Kumar, Rao and Rao, 2018). Supplier selection criteria have evolved

along with the changing business environment. Modern supply chains are faced with a variety of challenges, including conflicting criteria, demand uncertainty, lead times, and supply uncertainty (Kumar, Rao and Rao, 2018). In 1966 23 criteria were formulated that need to be considered in selecting suppliers. These criteria include fundamental aspects such as quality, price, reliability, capacity, to more complex aspects such as reputation, experience, technology, and innovation (Dickson, 1966). Then there are also those who make criteria such as cost, quality, and delivery time the main focus (Mohammed, 2020). However, as awareness of the importance of sustainability increases, criteria such as environmental and social are also beginning to be considered and developed to complement economic criteria (Gidiagba, Tartibu and Okwu, 2022; Hosseini, Flapper and Pirayesh, 2022). Geographical considerations also play a role, such as manufacturers in the United States preferring local suppliers to minimize delivery times, while manufacturers in Europe prefer suppliers that excel in environmental sustainability practices (Enayati and Özaltın, 2024).

The AHP method is the most popular and widely applied method to select the best suppliers in various industrial fields and adopt certain criteria that are in accordance with the characteristics of the industry. Research on the selection of the best suppliers with AHP in pharmaceutical companies (Manik, 2023), freight forwarder services (Mohsen, 2023), oil and gas companies (Gidiagba, Tartibu and Okwu, 2022), water treatment industry (Li et al., 2021), mining companies (Siregar, 2020), manufacturing companies (Pramita and Wirawan, 2019), power generation companies (Musyahidah, 2019), server and network maintenance companies (Nisa, 2016), automotive companies (Dweiri et al., 2016), and also geographically based such as social sustainability in India (Mani, Agrawal and Sharma, 2014). In general, the research tends to focus on economic criteria such as price, quality, delivery time, service and only some have started to include sustainability aspects in the social field (Mani, Agrawal and Sharma, 2014; Gidiagba, Tartibu and Okwu, 2022) and the environment (Musyahidah, 2019) are the criteria for selecting the best suppliers.

Although AHP has proven to be effective in supplier selection, linear programming comes as a powerful complement to optimize further decisions. Linear programming is present as a powerful tool to solve optimization problems such as in order allocation (Wayne, 2004). By using linear programming methods, it can help determine the optimal order quantity from each supplier, thereby minimizing procurement costs and maximizing profits (Nazar et al., 2019). The formulation of the linear programming model in this study refers to the previous research where the decision variable is to maximize the allocation of orders to each selected supplier with several limiting functions. The limiting function (Ghodsypour and O'Brien, 1998) includes supplier capacity (capacity), demand (demand), and quality (quality). The limiting function (Sanayei et al., 2008) includes capacity, demand, quality and cost. The limiting function (Nazar et al., 2019) includes capacity, demand and cost. This barrier fungi is then developed to be more suitable for the characteristics in packaging companies.

Previous studies have highlighted the importance of supplier selection as a complex multi-criteria decision-making process involving both qualitative and quantitative factors (Ishizaka & Labib, 2009; Ghadimi et al., 2018). The Analytic Hierarchy Process (AHP) has been widely applied across industries such as pharmaceuticals (Manik, 2023), oil and gas (Gidiagba et al., 2022), and logistics (Mohsen, 2023) to rank suppliers based on criteria like cost, quality, and delivery. Meanwhile, Linear Programming (LP) has proven effective in optimizing supplier allocation and minimizing procurement costs (Nazar et al., 2019; Sanayei et al., 2008). However, limited research integrates AHP and LP simultaneously while incorporating sustainability dimensions—economic, social, and environmental—in supplier selection, especially in the packaging industry using

polypropylene. This study is novel in combining AHP to determine criteria weights and LP to optimize order allocation while embedding comprehensive sustainability metrics. It provides a robust decision-making framework for improving procurement strategy in manufacturing, particularly under increased demand and competition post-pandemic.

Thus, this research is expected to contribute to the development of a better supplier selection model because it has integrated the AHP and LP methods in supplier selection in companies by adopting more comprehensive sustainability criteria, covering economic, social, and environmental aspects, in line with the global trend that increasingly emphasizes the importance of sustainability in the supply chain. The model developed is expected to be a reference for companies in managing the supply chain more effectively and efficiently and improving the company's image as an environmentally friendly entity because it has implemented sustainability criteria in its procurement process. The research aims to develop an integrated model to overcome the problem of supplier selection and raw material order allocation at PT. IKSG.

RESEARCH METHOD

The research flow chart can be seen in the following image

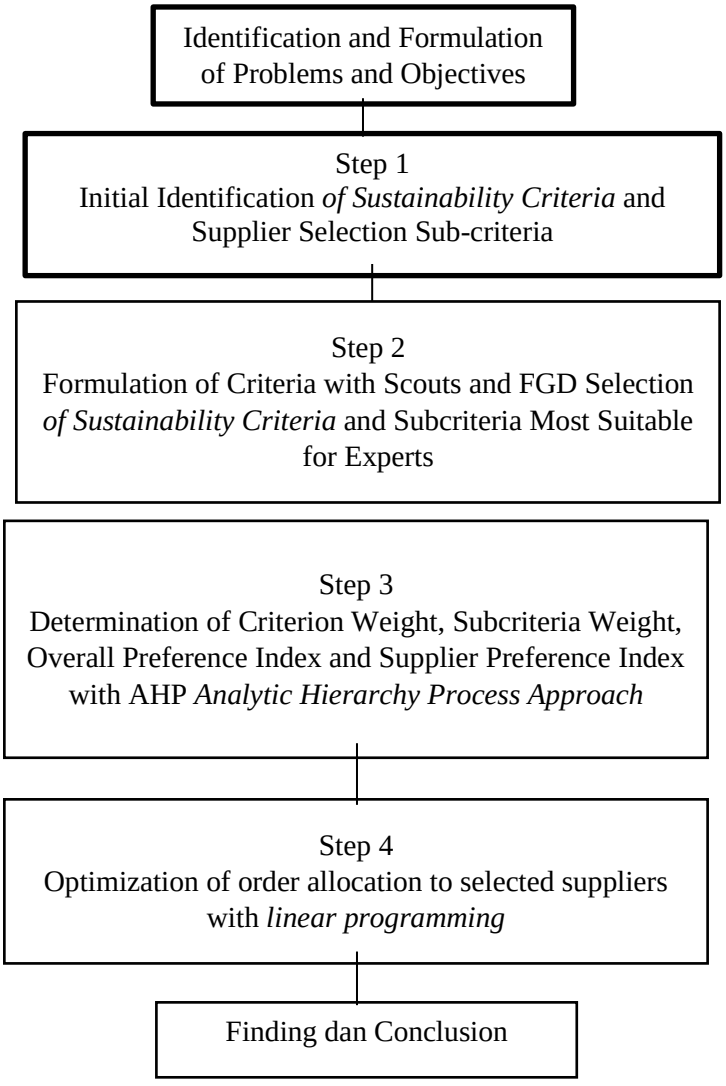


Figure 1. Research Flow

Identification, Formulation and Determination of Criteria and Subcriteria

Modeling of polypropylene raw material supplier selection strategies begins with the identification of preliminary criteria that may be relevant drawn from literature studies on previous research (Mani, Agrawal and Sharma, 2014; Gidiagba, Tartibu and Okwu, 2022; Hosseini, Flapper and Pirayesh, 2022; Wang et al., 2024). This criterion is then refined through the distribution of questionnaires given to selected respondents to give an assessment rating on each criterion and sub-criteria. The respondents for the preparation and formulation of criteria and subcriteria amounted to ten respondents consisting of five respondents from GIS and five respondents from PT IKSG. Reponden has a professional background in the field of procurement of goods and services as well as relevant supporting fields such as production, quality and auditing. The level of position of respondents varies from the level of manager, senior manager and general manager with more than 10 years of experience in their field. After the assessment rating, the next stage was a Focus Group Discussion (FGD) with all respondents. The goal is to reach a consensus regarding important criteria that suit the company's conditions and needs. This final criterion is then used as a foundation in modeling the best supplier selection strategy.

Modeling Supplier Selection Strategies With AHP

The AHP method is a method invented by Thomas L. Saaty, an actor at the University of Pittsburgh. He was the first to introduce this method as a tool in decision-making involving many complex actors. The Analytical Hierarchy Process (AHP) method works by breaking down complex problems into simpler hierarchies. The first step is to identify the main objectives, then break them down into more specific criteria. Furthermore, each criterion is compared in pairs to determine its relative weight. Alternative solutions are then evaluated based on each criterion. Using a paired comparison matrix, the weight of each alternative against each criterion is calculated. Finally, the overall weight of each alternative is calculated by multiplying the alternative weight against each criterion by the weight of that criterion. The end result of this calculation is the priority ranking of the various alternatives, which can be used as a basis for decision-making.

Sensitivity Analysis

In this study, sensitivity analysis was carried out using Super Decisions software. This step aims to determine the degree of influence of changes in the weight of the criteria on the alternative order of decisions produced. Through sensitivity analysis, the results to be obtained are information about the components of the hierarchical structure that are most sensitive to changes in their weights. Thus, it can be identified which factors or criteria are most influential in the assessment and decision-making process.

RESULT AND DISCUSSION

Determination of **Supplier Selection Criteria and Subcriteria**

After collecting the criteria and subcriteria rating data from the questionnaire, a Focus Group Discussion (FGD) was conducted to validate the results and determine the most relevant criteria and subcriteria for the selection of suppliers in the company. Through in-depth discussion, the respondents agreed to set an average score threshold of 4.4 as the minimum criterion for a subcriterion to be considered important and relevant. Subcriteria below this threshold are considered less significant or have been represented by other subcriteria that have higher scores. This decision was taken based on the consideration that subcriteria with a score above 4.4 are considered more relevant to the characteristics of procurement in the company, easier to implement, and more in line with the research objectives. For example, the subcriterion "compatibility" is considered to be superstitutable for "quality", and "green packaging" is considered less crucial because it can be met by using standard packaging.

Thus, the results of the FGD produce a more focused and relevant list of criteria and subcriteria, so that the resulting supplier selection model will be simpler but still comprehensive. So it was found that the economic criteria that were originally proposed to have 10 subcriteria were reduced to 6 subcriteria which include quality, cost, delivery, availability, financial and flexibility. The social criteria that were originally proposed had 5 subcriteria selected into 3 subcriteria which included worker safety, right of employee and working hours. As for the social criteria that were originally proposed, there were 5 criteria selected into 3 subcriteria which included waste management, environment related certificate, and reputation. More details can be seen in the following table:

Table 1. The social criteria

Initial Identification & Formulation (1)			Rating Responden (2)		FGD (3)
Criterion	**No**	**Sub Criteria**	**Total Score**	**Average**	**Determination of Subcriteria**
Economics	1	Quality	48	4,8	Accepted
	2	Cost	47	4,7	Accepted
	3	Delivery	46	4,6	Accepted
	4	Services	40	4	Rejected
	5	Technology	36	3,6	Rejected
	6	Financial	44	4,4	Accepted
	7	Availability	46	4,6	Accepted
	8	Flexibility	44	4,4	Accepted
	9	Relationship	34	3,4	Rejected
	10	Compatibility	39	3,9	Rejected
Social	1	Worker Safety	46	4,6	Accepted
	2	Social Management	35	3,5	Rejected
	3	Right of Employee	45	4,5	Accepted
	4	Working Hours	44	4,4	Accepted
	5	Culture	31	3,1	Rejected
Milieu	1	Waste Management	48	4,8	Accepted
	2	Reputation	46	4,6	Accepted

Initial Identification & Formulation (1)			Rating Responden (2)		FGD (3)
Criterion	No	Sub Criteria	Total Score	Average	Determination of Subcriteria
	3	Pollution Control	46	4,6	Accepted
	4	Green Packaging	38	3,8	Rejected
	5	Energy Management	36	3,6	Rejected

So that the hierarchical structure in the modeling of supplier selection in the company can be described as follows:

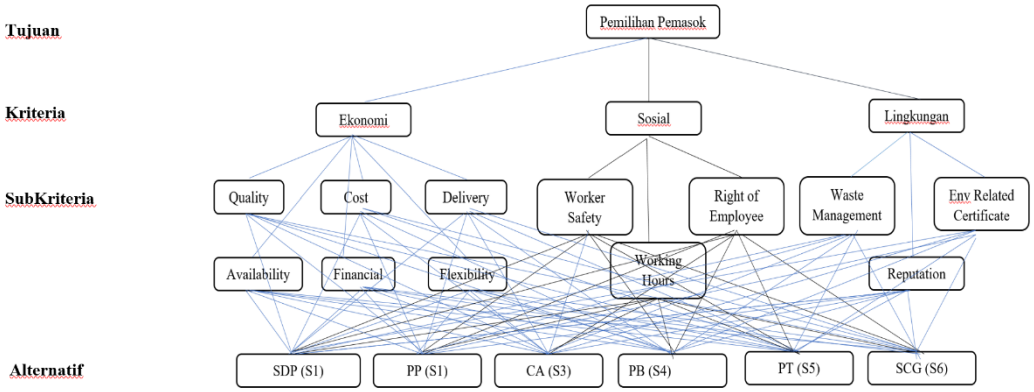


Figure 2. Hierarchical Structure

Results of Weighting of Criteria, Subcriteria, and Overall Preference Index

Using the hierarchy structure above, the next step is to determine the relative weight of each criterion and subcriterion. This weighting process aims to measure the level of importance of each element in supplier selection decision-making.

Table 2. Results of Criterion Weighting with Consistency Ratio 0.05 %

Criterion	Weight of Criteria	Peringkat
Economics	0,6316	1
Social	0,1017	3
Milieu	0,2667	2

The weighting results showed that the economic criteria had the highest weight (63.16%), followed by the environment (26.67%), and social (10.17%). This is in line with other research findings that emphasize the importance of economic factors. However, this study also shows that there are considerations for environmental and social aspects, in line with sustainability trends in business.

Table 3. Results of Weighting of Economic, Social and Environmental Subcriteria

Economic Sub-Criteria	Weighting Results	Social Subcriteria	Weighting Results	Environmental Subcriteria	Weighting Results
Quality	0,2918	*Worker Safety*	0,2342	*Waste Management*	0,4544

Cost	0,2236	*Right of Employee*	0,5051	*Environment Related Certificate*	0,1205
Delivery	0,0983	*Working Hours*	0,2607	*Reputation*	0,4250
Availability	0,1674	Consistency Ratio:			
Financial	0,0649	1. Economic Sub-Criteria 1.08 %			
Flexibility	0,1540	2. Social Subcriteria 1.51 %			
		3. Environmental Subcriteria 3.61%			

From table 2, it can be seen that the economic subcriteria have the highest weight. However, other subcriteria such as cost and availability also have a significant contribution. This shows that the company not only considers quality, but also strives to balance various economic aspects in choosing suppliers. From the social subcriteria, Workers' Rights have the highest weight, followed by Working Hours and the last is Worker Security. This indicates that in selecting suppliers, companies prioritize aspects of workers' rights. Meanwhile, from the environmental subcriteria, it can be concluded that in selecting suppliers, the company prioritizes the waste management aspect. This subcriterion gets the highest weight, indicating that the company cares deeply about the environmental impact of its business activities.

Table 4. Overall Preference Index

Criterion	Subkriteria	Preference Index Weights
Economics	Quality	0,1843
	Cost	0,1412
	Delivery	0,0621
	Availability	0,1057
	Financial	0,0410
	Flexibility	0,0972
Social	Worker Safety	0,0238
	Right of Employee	0,0514
	Working Hours	0,0265
Milieu	Waste Management	0,1212
	Environment Related Certificate	0,0322
	Reputation	0,1134
Sum		1

From table 3 the weight of the preference index shows that economic factors, especially product quality and cost, are the main considerations in the selection of suppliers. The company also pays attention to logistical aspects such as delivery and product availability to ensure a smooth production process. Nonetheless, the company does not neglect social and environmental aspects. Social criteria such as worker safety and employee rights are also considered, demonstrating the company's commitment to the welfare of workers at the supplier. In addition, a significant weight on the environmental subcriteria is waste management and supplier reputation shows the company's awareness of the importance of choosing sustainable suppliers.

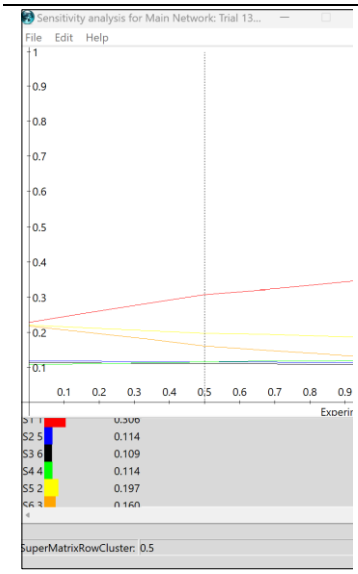
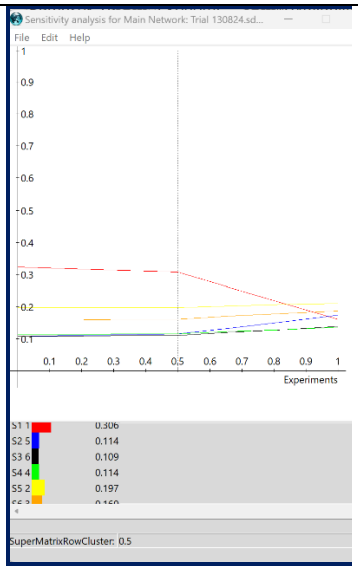
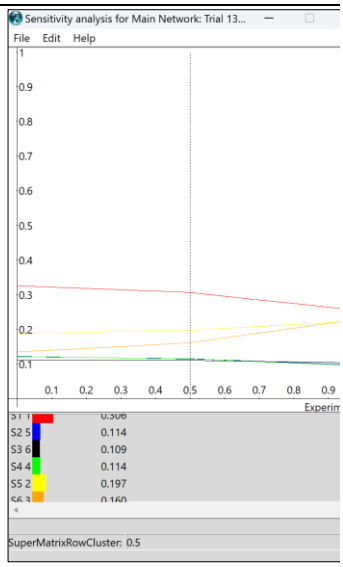
By taking into account the criterion preference index, subcriteria preferences and supplier preferences are weighted and ranked as follows:

Table 5. Supplier Selection Results

Supplier	Weight	Ranking
SDP (S1)	0,30447	1
PP (S2)	0,11439	5
CA (S3)	0,10910	6
PB (S4)	0,11443	4
PT (S5)	0,19776	2
SCG (S6)	0,15986	3

Based on the results of the weighting as listed in table 4.29, it can be concluded that SDP suppliers (S1) are the suppliers with the highest ranking, followed by PT (S5) and SCG (S6). This indicates that Shandong (S1) has the best performance based on the criteria that have been set, so it is considered as the most worthy supplier to be chosen. PP (S2), CA (S3), and PB (S4) suppliers have lower weights, indicating that their performance is less than optimal compared to the top three suppliers.

Table 6. Sensitivity Analysis

Sensitivity of Economic Criteria	Social Criterion Sensitivity	Sensitivity of Environmental Criteria
		

From the results of the weight change analysis for each criterion, the following results were obtained:

1. The sensitivity analysis on changes in the weights of economic criteria did not have a significant impact on supplier ratings. Although the weight of the economic criteria is lowered or increased, the order of supplier ranking remains consistent with the first order starting from SDP (S1), PT (S5), SCG (S6), PB (S4), PP (S2) and CA (S3). This shows that changes in the weight of economic criteria are not sensitive to changes in supplier selection rankings
2. The analysis of sessitivity on changes in the weight of social criteria has a significant influence on changes in supplier rankings. When the weight of social criteria is increased, there is a big change in the ranking of suppliers. The order of supplier rankings which was originally SDP (S1), PT (S5), SCG (S6), PB (S4), PP (S2) and CA (S3) changed to PT (S5), SCG (S6), PP (S2), SDP (S1), CA (S3) and PB (S4). This

shows that changes in the weight of social criteria are sensitive to changes in supplier selection rankings.

3. The sensitivity analysis on changes in environmental criteria weights shows that changes in environmental criteria weights have a significant impact on changes in supplier ratings. When the weight of the environmental criteria is increased, the ranking of suppliers which were originally SDP (S1), PT (S5), SCG (S6), PB (S4), PP (S2) and CA (S3) changed the ranking order to SDP (S1), SCG (S6), PT (S5), CA (S3), PP (S2), and PB (S4). This shows that changes in the weight of environmental criteria are sensitive to changes in supplier selection rankings.

Order Allocation For Selected Suppliers

In this order allocation modeling, it is divided into four periods of polypropylene raw material needs in the company, namely:

a. 1st period from July to September 2024
b. 2nd period from October to December 2024
c. 3rd period from January to March 2025
d. The 4th period is from April to June 2025.

The results of the order allocation optimization for each supplier are as follows:

Table 7. Results of The Order Allocation Optimization

Period	Supplier	Order Quantity (kg)	Number of Containers
1	SDP (S1)	450.000	17
	PT (S5)	28.882	2
	SCG (S6)	20.000	1
2	SDP (S1)	450.000	17
	PT (S5)	45.012	2
	SCG (S6)	20.000	1
3	SDP (S1)	450.000	17
	PT (S5)	105.710	4
	SCG (S6)	20.000	1
4	SDP (S1)	450.000	17
	PT (S5)	280.000	11
	SCG (S6)	20.000	1

From table 7 above, it can be seen that there is a difference in the number of polypropylene orders at several suppliers for each period with the largest number of orders held by SDP (S1) followed by PT (S5) and SCG (S6). This difference in the number of orders is based on the weight of the importance that each supplier has in the previous AHP calculation, where SDP (S1) has the largest weight when compared to the other two suppliers so that this is what causes the largest number of polypropylene orders from SDP (S1).

On the basis of order allocation, the level of fulfillment is measured for two main things, namely:

1) Fulfillment of raw material needs

The total order allocation supplied by the three suppliers in the entire period of 2,339,603 kg is greater than the total demand for raw materials of 2,263,259 kg. This is influenced by constrains related to the still sufficient purchase budget and storage warehouse capacity. Thus, the allocation of orders for the three suppliers can meet the needs of raw materials for each period as well as prevent stockouts because the company still has leftover or stock reserves in the warehouse that can be used in

anticipation of an increase in demand in a certain period

2) Compliance with the use of the budget
The budget available for the purchase of raw materials during the procurement period is IDR 40,738,664,094 while what is needed to fulfill the order allocation is IDR 40,704,892,500. So that there is still a remaining budget of IDR 33,771,594 as an efficiency of the process of fulfilling raw material needs in the company.

CONCLUSION

This study has succeeded in developing a comprehensive analytical hierarchy-based decision-making model (AHP) for the selection of polypropylene raw material suppliers in PT IKSG. The model has identified key criteria that include economic, social, and environmental aspects, as well as compiled subcriteria that are relevant to the characteristics of the company. The results of the evaluation show that the criteria of quality, cost, availability, flexibility, delivery, and finance are the most dominant economic factors in decision-making. Meanwhile, social and environmental aspects also have significant weight, demonstrating the company's commitment to sustainability.

However, this study has some limitations. The sensitivity analysis conducted was only limited to changes in the weight of the criteria, while the effect of changes in dynamic input data has not been studied in depth. So that for further research, a more comprehensive sensitivity analysis can be developed on the influence of changes in input data and interactions between criteria on the final result. Comparisons with other methods such as ANP or TOPSIS can be made to enrich the understanding and validity of the models used. In addition, a non-linear optimization approach can also be carried out to be able to provide more complex and accurate solutions.

REFERENCES

Dickson, G. W. (1966). An analysis of vendor selection systems and decisions. Journal of Purchasing, 2(1), 5–17. https://doi.org/10.1111/j.1745-493X.1966.tb00818.x

Dweiri, F., Kumar, S., Khan, S. A., & Jain, V. (2016). Designing an integrated AHP based decision support system for supplier selection in automotive industry. Expert Systems with Applications, 62, 273–283. https://doi.org/10.1016/j.eswa.2016.06.030

Enayati, S., & Özaltın, O. Y. (2024). A multi-criteria decision-making framework for sustainable supplier selection in the European manufacturing sector. Computers & Industrial Engineering, 187, 108123. https://doi.org/10.1016/j.cie.2024.108123

Ghadimi, P., Ghassemi Toosi, F., & Heavey, C. (2018). A multi-agent systems approach for sustainable supplier selection and order allocation in a partnership supply chain. European Journal of Operational Research, 269(1), 286–301. https://doi.org/10.1016/j.ejor.2017.07.034

Ghodsypour, S. H., & O'Brien, C. (1998). A decision support system for supplier selection using an integrated analytic hierarchy process and linear programming. International Journal of Production Economics, 56–57, 199–212. https://doi.org/10.1016/S0925-5273(97)00009-1

Gidiagba, E. O., Tartibu, L. K., & Okwu, M. O. (2022). Evaluation of supplier selection criteria and sustainability in oil and gas supply chains. Sustainability, 14(19), 12517. https://doi.org/10.3390/su141912517

Hossein, M., Flapper, S. D. P., & Pirayesh, M. (2022). Sustainability-oriented supplier selection using fuzzy logic and extended AHP. Journal of Cleaner Production, 332, 129964. https://doi.org/10.1016/j.jclepro.2021.129964

Ishizaka, A., & Labib, A. (2009). Analytic hierarchy process and expert choice: Benefits and limitations. OR Insight, 22(4), 201–220. https://doi.org/10.1057/ori.2009.10

Kumar, M., Rao, K. S., & Rao, R. R. (2018). Supplier selection problem: Comparative analysis of MCDM methods and research agenda. International Journal of Advanced Operations Management, 10(2), 103–127. https://doi.org/10.1504/IJAOM.2018.092408

Li, H., Li, Z., Huang, G., & Wu, Y. (2021). A novel hybrid MCDM model for supplier selection in the water treatment industry. Journal of Cleaner Production, 281, 124695. https://doi.org/10.1016/j.jclepro.2020.124695

Manik, S. (2023). Application of AHP in the selection of pharmaceutical suppliers. Jurnal Ilmu Manajemen, 11(1), 32–42. https://doi.org/10.31294/jim.v11i1.18397

Mani, V., Agrawal, R., & Sharma, V. (2014). Supplier selection using social sustainability: AHP-based approach in India. International Strategic Management Review, 2(2), 98–112. https://doi.org/10.1016/j.ism.2014.10.003

Mohsen, S. (2023). Prioritizing freight forwarder companies using AHP: A case study. Transport and Logistics Review, 5(1), 48–56. https://doi.org/10.29277/tlr.v5i1.117

Mohammed, A. (2020). Towards "gresilient" supply chain management: A quantitative study. Resources, Conservation and Recycling, 155, 104641. https://doi.org/10.1016/j.resconrec.2019.104641

Musyahidah, F. (2019). Supplier selection based on environmental sustainability criteria using AHP method. Indonesian Journal of Industrial Engineering, 7(2), 145–153. https://doi.org/10.24912/jti.v7i2.734

Nazar, A. F., Saputra, M., & Wicaksono, A. (2019). Order allocation optimization with linear programming: A case study. Jurnal Sistem dan Manajemen Industri, 3(2), 89–95. https://doi.org/10.30656/jsmi.v3i2.1872

Pramita, N. U., & Wirawan, A. (2019). Analisis evaluasi kinerja vendor berdasarkan penetapan kriteria vendor performance indicator (VPI) menggunakan metode analytical hierarchy process (AHP) pada PT. XYZ. JATI UNIK: Jurnal Ilmiah Teknik dan Manajemen Industri, 2(2), 113–122. https://doi.org/10.30737/jatiunik.v2i2.344

Sanayei, A., Farid Mousavi, S., & Yazdankhah, A. (2008). An integrated group decision-making process for supplier selection and order allocation using multi-attribute utility theory and linear programming. Journal of Applied Sciences, 8(15), 2828–2835. https://doi.org/10.3923/jas.2008.2828.2835

Schramm, V. B., Cabral, L. P. B., & Schramm, F. (2020). Approaches for supporting sustainable supplier selection: A literature review. Journal of Cleaner Production, 273, 123089. https://doi.org/10.1016/j.jclepro.2020.123089

Siregar, R. (2020). AHP application for supplier selection in mining companies. Jurnal Teknik Industri, 22(1), 32–40. https://doi.org/10.9744/jti.22.1.32-40

Sperling, L. H. (2001). Introduction to physical polymer science (3rd ed.). Journal of Chemical Education. https://doi.org/10.1021/ed078p1469.1

Wang, X., Zhang, Y., Liu, Q., & Li, F. (2024). Exploring optimal pathways for enterprise procurement management systems based on fast neural modeling and semantic segmentation. Heliyon, 10(2), e26474. https://doi.org/10.1016/j.heliyon.2024.e26474

Watanabe, R. (2001). Supply chain management: Konsep dan teknologi. Majalah Usahawan, No.02, TH XXX, Februari.

Wayne, L. W. (2004). Operations research: Applications and algorithms (4th ed.). Thomson Learning.