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Analysis of Pulp Molding Machine Selection Decision with the Application of Integration of the Ahp and Topsis Methods Case Study: Packaging Manufacturing Industry Company in Karawang

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Abstract

In new product development, the selection of production machines is one very important part because it will greatly affect the success of product development. PT X is a company engaged in the packaging manufacturing industry. Currently PT X is developing biodegradable packaging products that meet food grade standards. In this project's case study, there are four engine brands that will be considered for selection. This study aims to determine priority criteria and the best alternative Pulp Molding machine. This study integrates the AHP method with TOPSIS. The AHP method is used to weight assessment criteria supported by the use of Super Decisions software, while the TOPSIS method is applied to sort the ranking of alternative machines. This study succeeded in determining the most important criteria in determining the choice of engine, in this case the production capacity with a weight of 0.395, while the best alternative machine to choose is JKE with a preference value of 0,503. Thus, this research can contribute to PT X in determining the choice of Pulp Molding machine.

Keywords: AHP; TOPSIS; Production Machine Selection; Super Decisions Software

INTRODUCTION

Food packaging plays an important role in supporting the fulfillment of human food needs in daily life (Cazac-Scobioala & Vasiliev, 2024). Packaging serves as a protector of food from physical, chemical, and mechanical damage (Ahmed et al., 2022; Jadhav et al., 2021). One of the most popular types of food packaging used in Indonesia is styrofoam food packaging made of polystyrene material, which is still a type of petroleum-based plastic; users often choose plastic and styrofoam due to low price and practicality (Greenpeace Indonesia, 2019). However, the use of styrofoam as food packaging can cause both health and environmental problems, including styrene migration into foods and potential carcinogenic concerns (Pilevar et al., 2019; IARC, 2019), the release of microplastics and styrene under common use conditions (Wang et al., 2023), and widespread EPS fragments detected in marine environments (Chan et al., 2023).

Menurut Mukminah (2019), styrofoam terdiri dari polimer yang dihasilkan dari bahan tambahan kimia, sehingga kemasan makanan berbasis styrofoam mengandung senyawa seperti styrene, butyl hydroxytoluene (BHT), polystyrene, dan zat perusak ozon seperti CFCs. Senyawa aditif ini bisa bermigrasi ke dalam makanan yang dikemas, membahayakan kesehatan karena beberapa bersifat karsinogenik (Guazzotti et al., 2024; Ajaj et al., 2021). Selain menimbulkan masalah kesehatan, penggunaan besar-besaran styrofoam juga menyebabkan isu lingkungan; data dari LIPI memperkirakan bahwa antara 0,27 hingga 0,59 juta ton sampah—termasuk styrofoam—masuk ke laut Indonesia setiap tahun (Nicholas Institute, 2022; Anadolu Agency, 2019). Styrofoam menjadi jenis limbah plastik sekali pakai yang paling dominan di antara sampah plastik lainnya (Cordova et al., 2019; Lestari et al., 2019).

In the *Regulation of the Minister of Environment and Forestry Number P.75*, Article 6 Paragraphs 1 and 2, it is stated that producers must carry out packaging waste reduction by using products, product packaging, and/or containers that are easily decomposed by natural processes, generate as little waste as possible, and/or avoid the use of products, packaging, and/or containers that are difficult to decompose naturally.

Currently, packaging made of paper is a popular choice among consumers because it is relatively inexpensive, and paper packaging waste can decompose faster through natural processes (Khwaldia et al., 2010). Meanwhile, according to Marsh and Betty (2007) in Anggarkasih et al. (2018), recycled paper is often used as a material for making food packaging. Other studies, however, state that recycled paper and cardboard do not meet the requirements for direct food contact applications because processing and functional additives such as mineral oils, phthalates, and others can migrate from recycled paper to food (Deshwal et al., 2019). Furthermore, according to the Food Safety and Standards Authority of India (FSSAI), only virgin-grade paper packaging can be used for direct food-contact applications (FSSR, 2011). Similarly, Fadiji et al. (2016) state that for food-grade packaging applications, only virgin-grade paper can be used. Virgin-grade paper is made from natural materials such as wood fiber, bamboo, rice straw, *bagasse*, and similar sources.

Mordor Intelligence (2023) reported that the market size of paper packaging in Indonesia in 2023 was estimated at USD 13.46 billion and is projected to grow to USD 18.08 billion by 2028, with a Compound Annual Growth Rate (CAGR) of 6.07%. Data on the estimated market size of paper packaging for the period 2023 to 2028 is shown in Figure I.2.

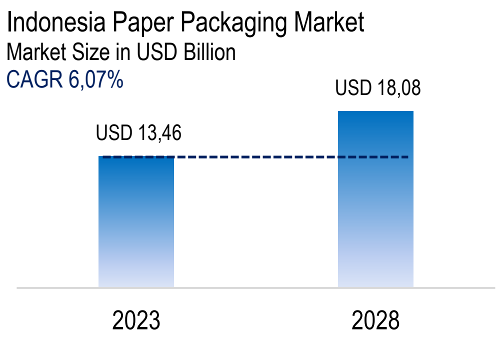

Figure 1. Overview of the Paper Packaging Market in Indonesia
Source: Mordor Intelligence (2024)

Based on this data, it is evident that the paper packaging market in Indonesia has great potential to boost the growth of the packaging industry. Meanwhile, competition in the biodegradable packaging or paper packaging market in Indonesia is becoming increasingly intense. In 2023, there were 13 large companies competing in the paper packaging market in Indonesia (Mordor

Intelligence, 2023). In the face of such fierce business competition, the company must be able to implement effective strategies to ensure the sustainability of its business.

PT X is one of the specialist packaging manufacturing companies. Some of the types of packaging products produced by *PT X* are *EPP*, *EPS*, and *Pulp Molded*. However, sales of *Pulp Molded* packaging products have not shown significant growth. Since the start of the paper pulp packaging production line in 2021 until now, there has been only one customer who places regular monthly orders. This is because *PT X*'s management is committed to producing high-quality products, resulting in higher product prices, which makes it difficult to win in price-based competition.

However, during 2024, *PT X* has had the opportunity to receive paper packaging orders from two new potential customers, both of which are food companies. Therefore, the R&D department of *PT X* is currently developing packaging products that meet food-grade standards. One of the most important stages in new product development is the selection of production machinery. Selecting the right production machine will determine the success of the new product development. The right production machine must be able to produce products with quality that meets established standards and have sufficient production capacity to meet market demand (Supriyatin, 2020).

Ramayanti & Ulum (2022) conducted a study aimed at determining the priority criteria and best alternatives for a filler machine. The method used was *AHP–TOPSIS*, where the *AHP* method was applied to weigh the assessment criteria, while the *TOPSIS* method was used to rank the alternative machines. In this machine selection case, there were five assessment criteria, namely: machine price, filling accuracy, filling speed, lead time availability, and maintenance team. The highest weight was in the maintenance team criterion, with a value of 0.34. Based on the *TOPSIS* calculation, it was found that the best machine alternative was from the *IMA* brand, with a preference value of 0.9084. Thus, the *AHP–TOPSIS* method can be used as a decision-making framework in the selection of production machines.

Other research states that integrating the *AHP–TOPSIS* approach with Goal Programming significantly contributes to improving the sustainability of a company's supply chain. This approach is effective for determining the optimal allocation of orders (Saputro et al., 2023).

Therefore, this study aims to propose a procedure for selecting a *Pulp Molding* machine by integrating the *AHP* and *TOPSIS* methods. The results of this research are expected to contribute to the company in determining the production machine to be purchased by considering various objectives and multiple criteria.

METHOD

Proposed Methods

To overcome the challenges in selecting *Pulp Molding* machines for the development of biodegradable packaging products with food-grade standards, this study integrates the *AHP* (*Analytical Hierarchy Process*) method with the *TOPSIS* (*Technique for Order Preference by Similarity to Ideal Solution*) method. The *AHP* method is used to weight the criteria in machine selection, while the *TOPSIS* method is applied to rank alternative machines based on the established criteria, thereby determining the most ideal machine alternative to choose. The framework of the research method applied in this machine selection study is shown in Figure 2.1 below.

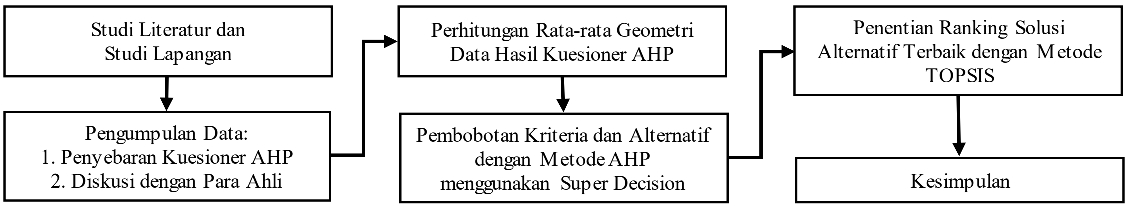

Figure 2. Framework for Pulp Molding Machine Selection

Source: Original creation by authors for this study

Determination of Criteria and Alternatives

The determination of criteria and alternatives was carried out using the *focus group discussion* method, involving several experts at *PT X*, including the *R&D Manager* (RM), *Engineering Manager* (EM), *Accounting Manager* (AM), and *Production Manager* (PM). At this stage, the experts formulated the criteria to be considered in the selection of machines and then proposed several alternative machine brands to be considered for purchase.

Weighting of Criteria with the AHP Method

The *AHP* (*Analytical Hierarchy Process*) method is a framework that can be used to support decision-making by speeding up and simplifying the decision-making process. It achieves this by breaking the problem down into components, arranging those components and variables hierarchically, and quantifying them based on subjective consideration of their importance. In the *AHP* method, each variable receives the highest priority in its context and acts to influence the outcome of the situation (Saaty, 1993). Here are the steps to use *AHP* (Willyandi & Septiani, 2022):

a). Step 1: Define the problem and formulate a solution by creating a hierarchical structure that begins with a general objective, criteria, sub-criteria and alternative options that are sorted.

b). Step 2: Create a comparison matrix in pairs between one criterion and another to weighting the level of importance. The weighting between the engine selection criteria in this study refers to table 1.

Table 1. AHP Importance Level Criteria

Importance Level	Information	Importance Level	Information
1	Equally Important	7	Very important
3	A Little More Important	9	Absolutely Very Important
5	Important	2, 4, 6, 8	Middle Scale

Source: Saputro et al., 2023

c). Step 3: Calculate the *geometric mean* of the AHP questionnaire (because it involves multiple respondents) using the formula in equation 1 below:

$$a_n = \sqrt[n]{a_1 x a_2 x a_3 x \ldots x a_i}$$

(1)

Where an : Combined Assessment n: Jumlah Expert

ai : Expert Assessment i-i

d). Step 4: Weighting Criteria and Alternatives using *Super Decision* software.

Determination of Ideal Alternatives with the TOPSIS Method

TOPSIS is a multi-criteria decision-making method or alternative selection that uses *Euclidean* distance to select alternatives that have a minimum distance to a positive ideal solution and a maximum distance to a negative ideal solution from a geometric point of view. TOPSIS ranks alternatives based on the priority value of the relative proximity of the alternative with a positive ideal solution. The alternatives evaluated are a reference for decision-makers to choose the optimal solution. In the TOPSIS method, it is necessary to provide *a performance rating* of each Ai alternative on each normalized Ci criterion. In general, the steps of the TOPSIS method are as follows (Willyandi & Septiani, 2022):

a). Normalize the alternative value of the solution and create a normalized matrix (r) using the following equation:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (4)$$

Where i : 1, 2, 3, … n (many alternatives)

n : 1, 2, 3, … n (many criteria)

b). Create a weighted normalized matrix (y), as follows:

$$y_{ij} = w_j \cdot r_{ij}$$

$$Y = \begin{vmatrix} y_{11} & y_{12} & y_{1j} \\ \vdots & \ddots & \vdots \\ y_{i1} & \cdots & y_{ij} \end{vmatrix} \quad (5)$$

c). Calculate the positive ideal solution matrix (A^+) and the negative ideal solution matrix (A^-):

$$A^+ = y_1^+, y_2^+, \dots, y_j^+ \quad (6)$$

$$A^- = y_1^-, y_2^-, \dots, y_j^- \quad (7)$$

Where

y+j : - Max yij, if j is an attribute of profit.

- Min yij, if j is an attributes cost

y^-_j : - Min yij, if j is an attribute of profit.

- Max yij, if j adalag cost attribute

d). Calculate the distance of the alternative value with the positive ideal solution matrix and the negative ideal solution matrix, using the equation in this example:

- The distance between the Ai alternative and the positive $D^{+i\ \text{solution}}$:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^+)^2}$$

$$i = 1,2,\dots,m \quad (8)$$

- The distance between the Ai alternative and the positive $^{D\text{-}i}{}_{\text{solution}}$:

$$D_i^- = \sqrt{\sum_{j=1}^{n}(y_{ij} - y_i^-)^2}$$
i = 1,2,…,m (9)

e). Specify the preference value for each alternative. The value of preference is the proximity of an alternative to the ideal solution. The preference value for each alternative (V_i) can be determined by using the following:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} ; i = 1,2,\ldots, m \quad (10)$$

A larger Vi value indicates that an Ai alternative is preferred.

Data and Case Studies

The data of this study is based on a case study of the selection *of Paper Mold* machines in the development of biodegradable *food packaging products* with *food grade* standards in packaging manufacturing industry companies. Through *the brainstorming process*, experts agreed that in the selection of this machine, it is necessary to consider 4 criteria, namely: Efficiency, Price, Capacity and Reliability. The alternatives proposed to be assessed and selected consist of 3 engine brands, namely: FJN, JKE and TPM. The criteria and alternatives that have been determined are then formulated into the hierarchical structure of the AHP shown in figure 2.2.

The criteria and alternatives that have been set by the experts are then compiled into a paired comparison matrix to carry out the weighting of the level of importance through an interview process with experts totaling 4 people, each expert gives the weight of the level of importance independently, the criteria in the weighting refer to table 2.1. Because the weighting in the paired comparison of each criterion and alternative in this study was carried out by more than 1 respondent, the weighting data was calculated using the *geometric mean* using equation (1). The data from the weighting of criteria (level 1) is shown in table 2.2, while the data of alternative weighting results based on criteria (level 2) is shown in table 2.3.

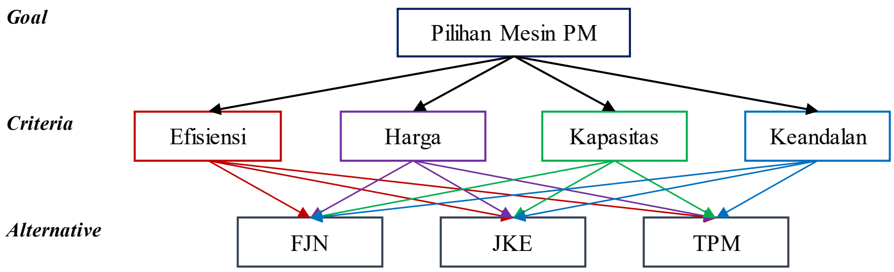

Figure 3. AHP Hierarchical Structure
Source: Original creation by authors based on expert input (PT X's FGD results)

Table 2. Weighting Results Between Criteria (Level 1)

Criteria A	Criteria B	Respond R1	R2	R3	R4	Geo. Mean Criteria A	Geo. Mean Criteria B
Efficiency	Price	0,11	0,14	3	1	0	2
Efficiency	Capacity	0,14	0,25	3	0,33	0	2

Efficiency	Reliability	3	0,33	0,20	0,14	0	2
Price	Capacity	8	0,33	0,20	0,11	0	2
Price	Reliability	0,14	7	7	0,33	1	1
Capacity	Reliability	8	1	0,33	7	2	0

Source: Processed data from expert respondents (R1–R4) using geometric mean (Equation 1)

Table 3. Results of Weighting Between Alternatives Based on Criteria (Level 2)

Criteria	Alternative		Respond				Geo. Mean	
			R1	R2	R3	R4	Alternative	
	A	B					A	B
Efficiency	FJN	JKE	2	2	5	7	3	0
	FJN	TPM	0,33	0,14	0,13	0,14	0	6
	JKE	TPM	0,14	0,13	0,11	0,14	0	8
Price	FJN	JKE	0,14	0,17	0,20	0,20	0	6
	FJN	TPM	7	3	1	5	3	0
	JKE	TPM	9	9	5	5	7	0
Capacity	FJN	JKE	0,20	0,50	0,33	0,20	0	3
	FJN	TPM	8	5	6	7	6	0
	JKE	TPM	9	7	7	9	8	0
Reliability	FJN	JKE	1	3	7	5	3	0
	FJN	TPM	0,33	0,14	0,13	0,13	0	6
	JKE	TPM	0,14	0,13	0,11	0,11	0	8

Source: Processed data from expert respondents (R1–R4) using geometric mean (Equation 1)

RESULTS AND DISCUSSION

Pulp Molding Machine Selection

In this case study of the selection of Pulp Molding machines, a decision-making framework is proposed by integrating the AHP and TOPSIS methods. The first stage is to carry out weighting criteria and alternatives using the AHP method. Then the second stage is to determine the ranking of the machine alternatives based on the closest distance to the positive ideal solution and the farthest distance from the negative ideal solution using the TOPSIS method.

1. **Weighting of Criteria and Alternatives with the AHP Method**

The weighting of criteria and alternatives with the AHP method carried out in this study was carried out with the help of *Software* Super Decisions.

The first step is to formulate the criteria and alternatives that have been set by experts into the structure of the AHP Hierarchy as shown in Figure 4.

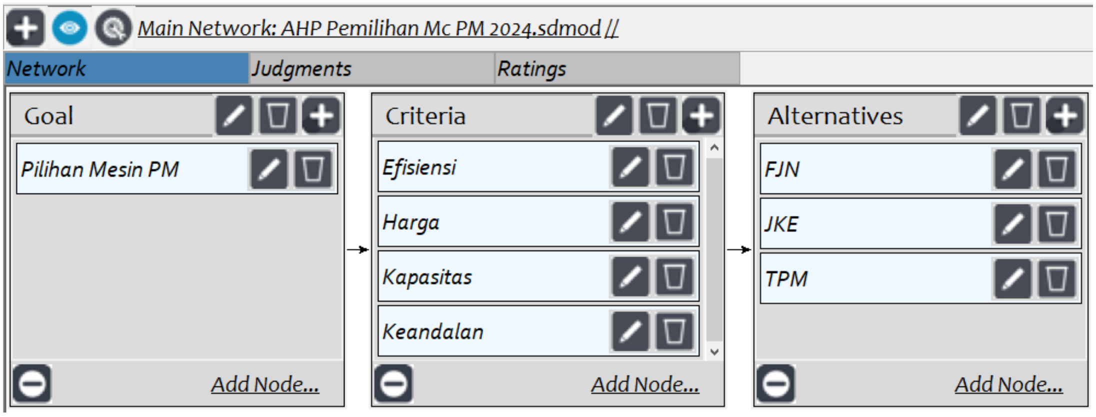

Figure 4. AHP Hierarchical Structure of PM Machine Selection on Super Decision
Source: Screenshot of Super Decisions software output (Adams & Saaty, 2003)

The second step is to weighting the criteria and alternatives by entering the *geometric mean value* of each comparison of pairs of criteria and alternatives into the questionnaire contained in the *"Judgments" menu bar in* the Super Decision software. The results of the weighting between the criteria are shown in Figure 5, the criterion that has the highest weighting value is capacity, with a value of 0.395, while *the inconsistency* value is 0.02 (more than 0.1), which means that this weighting has been done consistently.

The results of weighting between alternatives based on criteria are shown in figures 6 to 9, alternative JKE machines have the highest weight value in price and capacity criteria, while TPM machines excel in the weight value of efficiency and reliability criteria. The *inconsistency value* in the comparison between the alternatives of each criterion is less than 0.1, so it can be stated that this weighting meets the consistency requirement.

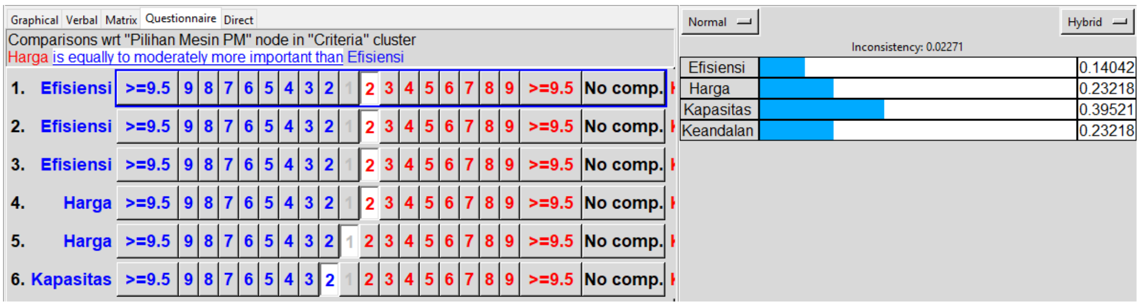

Figure 5. Weighting Between Criteria (Level 1) in Super Decision Software
Source: Screenshot of Super Decisions software output (Adams & Saaty, 2003)

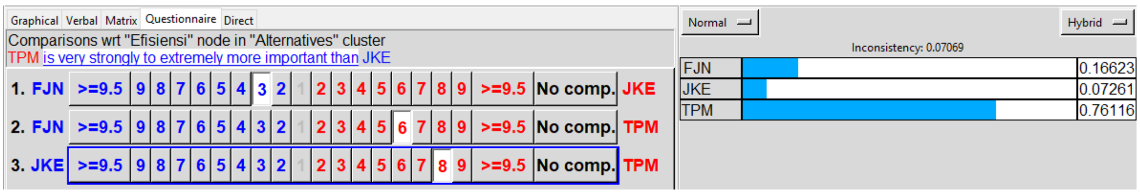

Figure 6. Weighting between alternatives (level 2) on efficiency criteria
Source: Screenshot of Super Decisions software output (Adams & Saaty, 2003)

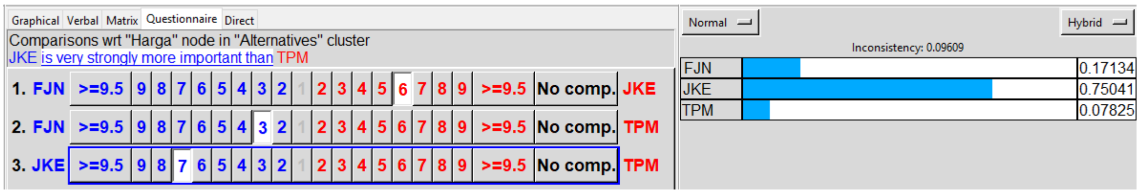

Figure 7. Weighting Between Alternatives (Level 2) on Price Criteria
Source: Screenshot of Super Decisions software output (Adams & Saaty, 2003)

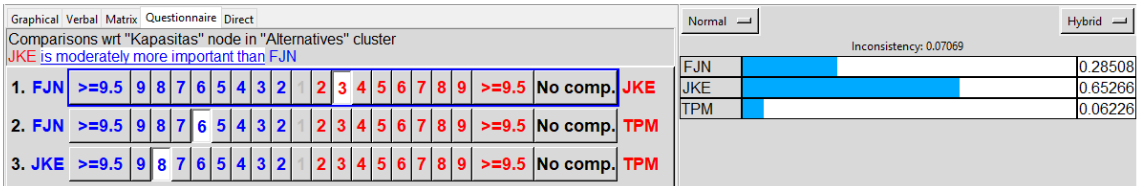

Figure 8. Weighting between alternatives (level 2) on capacity criteria
Source: Screenshot of Super Decisions software output (Adams & Saaty, 2003)

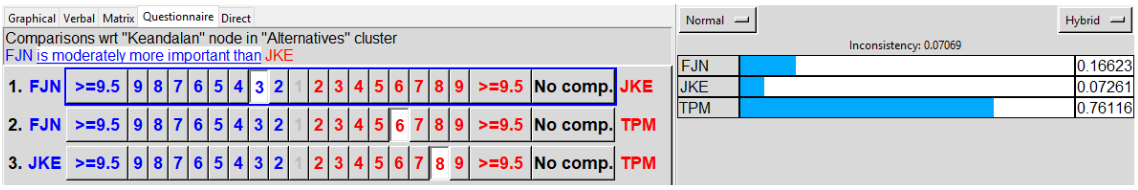

Figure 9. Weighting between alternatives (level 2) on reliability criteria
Source: Screenshot of Super Decisions software output (Adams & Saaty, 2003)

The third step is to determine the most ideal machine alternative to choose by using the *synthesized function* in the *"*Computations*"* ribbon menu *in* the Super Decisions software. The *synthesized* results are shown in Figure 7, which shows that based on the analysis of the AHP method on the Super Decision software, the JKE machine is the most ideal alternative to choose.

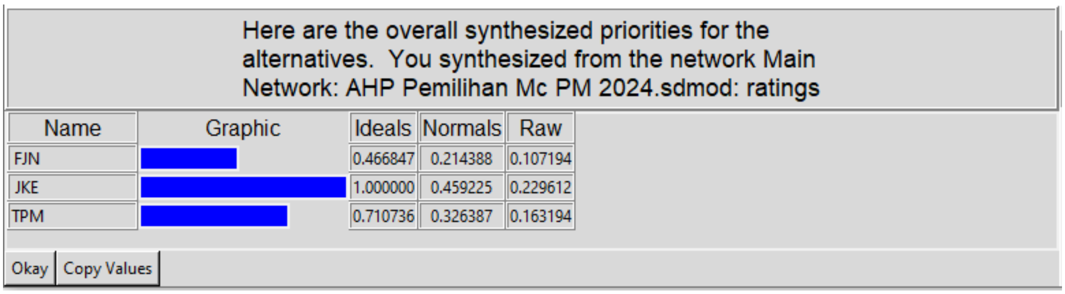

Figure 10. Ideal Alternative Selection Results using Super Decisions Software
Source: Screenshot of Super Decisions software output (Adams & Saaty, 2003)

The results of phase 1 data analysis with the AHP method have resulted that the JKE machine is the ideal alternative to be chosen, but this study requires a more complex and objective analysis in order to get a more optimal decision in the selection of a Pulp Molding machine, so the analysis is continued in stage 2 by applying the TOPSIS method

2. Determining Alternative Machine Ranking with the TOPSIS Method

The first step taken at this stage is to enter the value of the AHP level 2 weighting results obtained from the Super Decision software into the TOPSIS decision matrix, then at this stage the percentage of importance level of importance is also weighted to the criteria in the selection of the machine based on the preferences of *the top management* of PT X, with the results shown in table 4 below.

Table 4. TOPSIS Decision Matrix with Weighted Criteria from PT X's Top Management

Alternative	Criterion			
	Efficiency	**Price**	**Capacity**	**Reliability**
FJN	0,166	0,171	0,285	0,166
JKE	0,073	0,750	0,653	0,073
TPM	0,761	0,078	0,062	0,761
Category	Benefit	Cost	Benefit	Benefit
Weight (Top Management)	0,1	0,3	0,4	0,2

Source: Processed data from AHP Level 2 results (Super Decisions) and PT X's management preferences

The second step is to normalize the alternative value of the solution by formulating a normalized matrix (r) using equation 4. This stage aims to scale the data to a uniform shape so that each criterion has equal weight in the calculation. The following is one of the calculations described in calculating the normalization of the value of alternative solutions applied to alternative 1:

$$r1 = \frac{0{,}166}{\sqrt{0{,}166^2 + 0{,}073^2 + 0{,}761^2}} = 0.212$$

By the method of calculation described in equation 4, all alternative machine choices are calculated for their normalization value. The results of the overall calculation of the normalization of the alternative value of the solution are formulated into the normalized matrix (r) shown in table 5.

Table 5. Normalization of Alternative Value Solutions

Alternative	Normalized Matrix (r)			
	Efficiency	**Price**	**Capacity**	**Reliability**
FJN	0,212	0,221	0,399	0,212
JKE	0,093	0,970	0,913	0,093
TPM	0,973	0,101	0,087	0,973

Source: Calculated using Equation 4 (TOPSIS method)

The third step at this stage is to form a weighted normalized decision matrix (y) using equation 5, this step is carried out to consider the importance of each criterion in the decision-making process. Here is one of the calculations to form a weighted normalized decision matrix applied to alternative 1:

$$\mathbf{y1 = 0.1 \times 0.212 = 0.021}$$

In the same calculation method, all alternative machine options are calculated for their weighted normalization value. The overall calculation results of weighted normalization are formulated into the weighted normalized decision matrix (y) shown in table 3.2.

Table 6. Weighted Normalized Decision Matrix

Alternative	Weighted Normalized Matrix (y)			
	Efficiency	Price	Capacity	Reliability
FJN	0,021	0,066	0,160	0,042
JKE	0,009	0,291	0,365	0,019
TPM	0,097	0,030	0,035	0,195

Source: Calculated using Equation 5 (TOPSIS method)

The fourth step is to create a positive ideal solution matrix (A^+) and a negative ideal solution matrix (A^-). This step aims to provide a benchmark for comparison used in assessing and determining the best alternative. In this study, the determination of the value of the ideal positive solution (A^+) uses the principle that if the criteria analyzed have the category "Benefit", the highest alternative value is chosen, but if the criteria analyzed have the category "Cost", the lowest alternative value is chosen. As for the determination of the value of the negative ideal solution (A^-) using the opposite principle, namely the selection of the highest alternative value for the "Cost" category and the highest alternative value for the "Benefit" category. The results of the determination of the positive ideal solution and the overall negative ideal solution are shown in table 7.

Table 7. Positive and Negative Ideal Solution Matrix

The Ideal Solution	Efficiency	Price	Capacity	Reliability
Ideal (+)	0,097	0,030	0,365	0,195
Ideal (-)	0,009	0,291	0,035	0,019

Source: Calculated using Equations 6–7 (TOPSIS method)

The fifth step is to calculate the distance of the alternative value with the positive ideal solution matrix (D^+) and the negative ideal solution matrix (D^-), using the equation
8, this process aims to determine how close or far each alternative is from the best and worst conditions. The following is one of the elaborations of the calculation of the D^+ and D^- values for alternative 1:

$$D+1 = \sqrt{(0{,}097 - 0{,}021)^2 + (0{,}030 - 0{,}066)^2 + (0{,}365 - 0{,}160)^2 + (0{,}195 - 0{,}042)^2} = 0.269$$

$$D\text{-}1 = \sqrt{(0{,}021 - 0{,}009)^2 + (0{,}066 - 0{,}291)^2 + (0{,}160 - 0{,}035)^2 + (0{,}042 - 0{,}019)^2} = 0.258$$

The overall results of the calculation of D^+ and D^- values for all alternatives, are shown in table 8.

Table 8. Alternative Distance to Ideal Solutions Positive (D+) and Negative (D-)

Alternative	D+		D-	
FJN	D1+	0,269	D1-	0,258
JKE	D2+	0,327	D2-	0,330
TPM	D3+	0,330	D3-	0,327

Source: Calculated using Equations 8–9 (TOPSIS method)

The final step at this stage is to calculate the preference value for each alternative using equation 9, this process aims to rank the alternatives based on their proximity to the positive ideal solution and its distance from the negative ideal solution. Below is the calculation of the preference value for alternative 1:

$$V1 = \frac{0,258}{(0,258+0,269)} = 0.490$$

The overall results of the calculation of the preference value (V) for all alternatives are shown in table 9. Once all preference values have been obtained, the final process is to sort the *ranking* of each alternative, referring to the principle that the alternative that has the highest preference value is the best alternative solution.

Table 9. Preference Values and Ranking of Each Alternative

Alternative	Preferences	Rank
V1 (FJN)	0,490	3
V2 (JKE)	0,503	1
V3 (TPM)	0,497	2

Source: Calculated using Equation 10 (TOPSIS method)

In table 9 above, it can be seen that alternative 2 (JKE machine) is the alternative that has the highest preference value with a preference value of 0.503 so that this alternative becomes the best alternative rank 1, in other words the JKE machine is the most ideal Pulp Molding machine to be purchased by PT X. These results show that JKE machines have advantages in criteria that are prioritized by the company, namely having the highest production capacity and relatively low prices.

This research shows that the JKE brand is the best alternative in the selection of *Pulp Molding* machines for PT X. This decision is based on the highest preference value in the decision analysis with the application of the AHP method combined with the TOPSIS method, where both methods produce the same alternative solution, namely the JKE machine is the best choice. Thus, it can be underlined that JKE machines have advantages over other alternatives. This is targeted because the alternative is considered to have a high production capacity, but the purchase price of this machine is still affordable.

The results of this study are in accordance with the results of research conducted by Willyandi & Septiani (2022), which revealed that the AHP method combined with the TOPSIS method proved to be effective as a decision-making framework in the selection of production machines, providing more objective and reliable decisions for the company, in the study, the AHP method was used to determine the weight of the criteria, while the TOPSIS method was used to sort alternatives based on its proximity to the ideal solution.

Research Implications

The theoretical implication of this study is the development of an integrated method between AHP and Topsis that uses the help of Super Decisions software as a holistic approach to handle the selection of Pulp Molding machines in the development of *biodegradable food grade packaging products*. This approach provides a strong theoretical foundation in determining the weight of the criteria for the selection of Pulp Molding machines with the AHP method supported by the use of Super Decisions software, then ranking the best machine alternatives based on the criteria in the selection of production machines using the Topsis method. Thus, this study expands theoretical insights in integrating various methods to improve the multi-criteria decision-making process in a case study of production machine selection.

CONCLUSION

Based on the results of the study and analysis of the case study on the selection of *Pulp Molding* machines using the *AHP* method, it was determined that there are four criteria considered in choosing the machine, namely efficiency, price, capacity, and reliability. Among these criteria, capacity was identified as the most important, with a weight value of 0.395. Meanwhile, the determination of the most ideal machine alternative was carried out using the *TOPSIS* method. The analysis results indicated that the *JKE* machine was the best alternative, with a preference value of 0.503. This outcome is attributed to the *JKE* machine's advantages in the criteria deemed most important in the development of biodegradable, food-grade packaging products—particularly its superior production capacity and relatively lower price.

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