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AN INTEGRATED AHP-MFEP DECISION SUPPORT MODEL FOR IMPROVING PRODUCT RECOMMENDATION ACCURACY IN FASHION RETAIL

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Abstract

The development of decision support systems has become essential in assisting businesses to make accurate and objective decisions, especially in product selection processes. However, many retail businesses still rely on manual decision-making, which is often subjective and inconsistent. This study aims to develop a decision support system using the Analytical Hierarchy Process (AHP) and Multi-Factor Evaluation Process (MFEP) methods to improve the accuracy and consistency of product recommendations. The AHP method is used to determine the weight of each criterion through pairwise comparisons, while the MFEP method is applied to evaluate and rank product alternatives based on these weights. The criteria used in this study include sales, profit, and customer preferences. Data collection was conducted through observation, interviews, and documentation. The results show that the system is able to generate structured and objective product rankings. The highest score obtained is 4.6, indicating the most recommended product alternative. Furthermore, the evaluation results show that the system achieves an accuracy of 92% and a precision value of 90%, indicating high relevance of the recommendations. In addition, the Spearman Rank Correlation value of 0.95 indicates a very strong agreement between the system results and expert judgment. Therefore, the proposed system is effective in improving decision-making accuracy, reducing subjectivity, and providing reliable product recommendations.

Keywords: *Decision Support System, AHP, MFEP, Recommendation, Fashion*

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1. INTRODUCTION

In the era of increasingly intense competition in the fashion retail industry, businesses are required to provide the right products to customers quickly and accurately [1] [2]. Modern consumers not only consider product quality but also expect personalized recommendations, responsive service, and a satisfying shopping experience [3] [4]. Therefore, retail businesses such as Bella Butik must manage product selection and recommendation processes systematically to remain competitive [5].

As the number and variety of products increase, manual methods of selecting and recommending products become less effective [6]. Product selection is no longer determined solely by sales volume but also involves multiple criteria, such as profit margin, demand trends, product quality, and customer satisfaction [7]. However, decision-making processes that rely on managerial intuition tend to be subjective, time-consuming, and prone to errors [8]. This condition may lead to inefficient inventory management, ineffective promotional strategies, and decreased customer satisfaction [9].

To overcome these challenges, a Decision Support System (DSS) is required to assist in evaluating and selecting products based on multiple criteria in an objective and structured manner [10] [11]. DSS enables decision-makers to process data quantitatively, resulting in more accurate, consistent, and data-driven decisions [12].

Several methods have been widely used in DSS, including the Analytic Hierarchy Process (AHP) and the Multi-Factor Evaluation Process (MFEP) [13] [14]. AHP is effective in determining the weight of each criterion through pairwise comparisons, while MFEP is used to evaluate and rank alternatives based on these weights [15]. The combination of AHP and

MFEP provides a comprehensive approach for multi-criteria decision-making [16].

However, previous studies generally apply AHP or MFEP as standalone methods or in domains outside fashion retail. Furthermore, limited research has explored the integration of AHP and MFEP specifically for product recommendation systems in small-scale retail businesses. This indicates a research gap in developing an integrated decision support model that can generate accurate and objective product recommendations in the fashion retail context.

Therefore, this study proposes an integrated AHP-MFEP model to support product recommendation decisions at Bella Butik. The proposed system aims to improve decision-making accuracy, reduce subjectivity, and enhance operational efficiency. The results of this study are expected to provide both practical benefits for retail businesses and academic contributions in the development of multi-criteria decision support systems.

2. RESEARCH METHOD

This study employs a quantitative method; the research stages are illustrated in Figure 1 below:

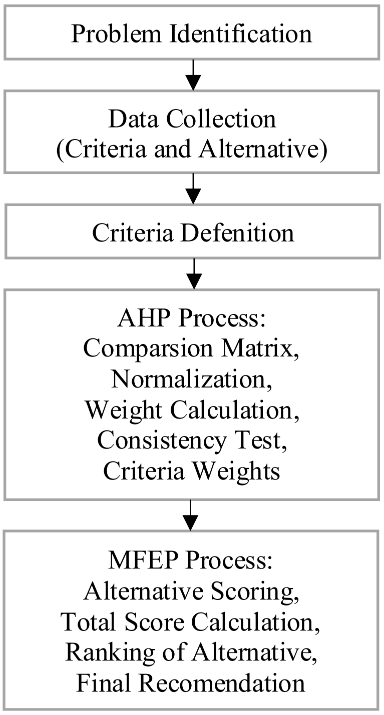

Figure 1. Research Stage

Figure 1 illustrates the proposed AHP–MFEP decision support model used in this study. The process begins with problem identification and data collection, where criteria and alternative products are determined based on business needs. These criteria are then defined and structured to support the decision-making process.

The Analytical Hierarchy Process (AHP) is applied in the criteria weighting stage. In this stage, pairwise comparisons are conducted to evaluate the relative importance of each criterion. The comparison results are then normalized to obtain the priority weights, followed by a consistency test using the Consistency Ratio (CR) to ensure the reliability of the judgments. The output of this stage is a set of valid and consistent criteria weights.

These weights are subsequently used as input in the Multi-Factor Evaluation Process (MFEP) stage. In this stage, each alternative is evaluated based on the predefined criteria. The evaluation is performed by assigning scores to each alternative, which are then multiplied by the corresponding weights to calculate the total score.

The final result of the process is a ranking of alternatives, where the highest score represents the most recommended product. This model demonstrates a sequential integration between AHP and MFEP, where AHP functions as a weighting method and MFEP as a ranking method, resulting in a structured, objective, and consistent decision-making process.

2.1 Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP) method is used to determine the relative importance of each criterion through pairwise comparisons. The normalization of the pairwise comparison matrix is performed to obtain the priority vector, as shown in Equation (1).

$$A = [aij] \quad aij = \frac{wi}{wj} \tag{1}$$

Each element in the matrix represents the relative importance between criteria. The matrix is then normalized to obtain the priority vector (criteria weights). The normalization process is calculated as with equaation (2):

$$wi = \frac{\sum_{j=1}^{n} aij}{n} \tag{2}$$

To ensure consistency in judgment, the Consistency Ratio (CR) is calculated. model as shown in Equation (3):

$$CR = \frac{CI}{RI} \tag{3}$$

Where:

CI = Consistency Index
RI = Random Index
A CR value less than 0.1 indicates that the comparison matrix is consistent.

2.2 Multi-Factor Evaluation Process (MFEP)

The Multi-Factor Evaluation Process (MFEP) method is used to evaluate and rank alternatives based on the criteria weights obtained from the AHP method. The final score of each alternative is calculated using a weighted summation model as shown in Equation (4).

$$Si = \sum_{j=1}^{n} Wj * Xij \quad (4)$$

Where Si = total score of alternative, wj = weight of criterion and xij = performance value of alternative. The alternative with the highest score is considered the best choice.

2.3 Implementation Prosedure

The implementation of the proposed model in the system follows these steps:

1. Input criteria and alternatives into the system
2. Perform pairwise comparison to generate criteria weights
3. Normalize the comparison matrix
4. Evaluate each alternative using predefined criteria values
5. Calculate final scores using MFEP
6. Display ranking results.

2.4 Evaluation Of System Performance

To evaluate the effectiveness of the proposed AHP-MFEP model, several performance metrics were used, including accuracy, precision, and Spearman Rank Correlation.

1. Accuracy
   Accuracy measures how many system recommendations match expert judgments [17]. can be calculated using the following equation (5).

$$Accuracy = \frac{Number\ of\ Correct\ Prediction}{Total\ Prediction} \quad (5)$$

2. Precision
   Precision evaluates how relevant the recommended products are [18]. can be calculated using the following equation (6).

$$Precision = \frac{Relevant\ Recommendations}{Total\ Recommendations} \quad (6)$$

3. Spearman Rank Correlation
   Spearman Rank Correlation is used to measure the similarity between the ranking produced by the system and the ranking determined by experts [19]. can be calculated using the following equation (7)

$$p = 1 - \frac{6 \sum di}{n\,(n2-1)} \quad (7)$$

   Where Di = difference beetween ranks and N = number of alternative

3. RESULT AND DISCUSSION

3. 1 Data and Criteria

The first step is to identify the alternatives, criteria, and weights, as shown in Table 1.

Table 1. Alternatif and Criteria Data

Alterantif Code	Alternative Name	Criteria Name	Weight
A1	Woman Dress	Seller Quantity	0.5
A2	Blouse	Provit Margin	0.2
A3	Long Skirt	Trend Request	0.1
A4	Tunic	Product Quality	0.1
A5	Woman Shirt	Consumer Satisfaction	0.1

This study uses five alternatives and five decision criteria, namely sales quantity, profit margin, demand trend, product quality, and customer satisfaction. Each criterion plays an important role in determining the most recommended product.

The combination of the AHP and MFEP methods serves as an effective solution for companies. AHP is used to analyze criteria, resulting in criteria with good consistency. Subsequently, the alternatives are ranked using the MFEP method. With this system, the administrator can identify which recommended products should be prioritized for evaluation. After normalizing the matrix, the results of the MFEP method calculations are presented in Table 2 below.

AHP Weight Result

Using the AHP method, pairwise comparisons were conducted to determine the importance of each criterion. The results show that sales quantity has the highest weight, followed by profit margin, demand trend, product quality, and customer satisfaction. The consistency ratio (CR) value obtained is below 0.1, indicating that the comparison matrix is consistent and reliable.

Table 2. MFEP Calculation Result

Alternative	Value	Rank
Woman Dress	4.6	1
Blouse	4.4	2
Long Skirt	3.7	3
Tunic	3.3	4
Woman Shirt	3	5

These results indicate that Women Dress is the most recommended product based on multi-criteria evaluation. Based on the results of the MFEP method, the Women's Dress alternative (A1) has the highest evaluation score of 4.6, making it the most recommended product to offer to customers at Bella Butik.

3.2 System Design

In general, the system process to be designed is illustrated by the Use Case Diagram shown in Figure 2 below.

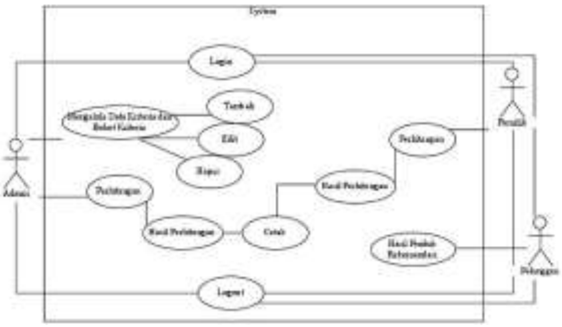

Figure 2. Use Case Diagram

Figure 2 illustrates the workflow of the decision support system using the integration of AHP and MFEP methods. The process begins with input data, including criteria and alternative products to be evaluated. In the first stage, the AHP method is applied to perform pairwise comparisons among criteria in order to determine their relative importance. The result of this stage is a set of normalized weights along with a consistency ratio to ensure the reliability of the comparisons.

In the next stage, the MFEP method is used to evaluate each alternative based on the weights obtained from the AHP process. Each alternative is assigned a score for every criterion, which is then multiplied by the corresponding weight to calculate the total evaluation score.

The final output of this process is a ranking of alternatives based on their total scores, where the highest score indicates the most recommended product. This workflow demonstrates how the integration of AHP and MFEP ensures a structured, objective, and consistent decision-making process.

3.3 Implementation System

1. Dashboard Page

This page is the starting page before using the decision support system.

Figure 3. Dashboard Page

2. Alternative Page

The data is used to manage the data contained in the system set up by the administrator.

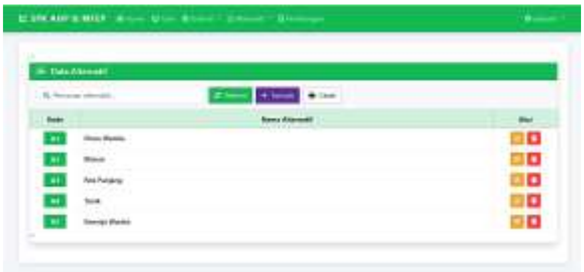

Figure 4. Alternative Page

3. Criteria Page

This form is used to enter the parameters required by the system. Once the parameters have been entered, the system can execute the process according to the algorithm embedded within it.

Figure 5. Criteria Page

4. Calculation Page

The results are presented as a ranking based on the total scores calculated by the decision support system.

Figure 6. Calculation Page

5. Report Page

This page displays the final results of the calculation, which can be printed.

Figure 7. Report Page

3.4 Result Interpretation

The calculation results show that the Spearman correlation value is close to 1, indicating a strong agreement between the system-generated ranking and expert judgment. This demonstrates that the AHP-MFEP model produces reliable and accurate recommendations. Based on the evaluation results, the accuracy value obtained by the system is 92%, indicating that most of the product recommendations generated by the system are consistent with expert judgments. This shows that the system is able to provide correct recommendations in the majority of cases.

The evaluation of the system performance was conducted using 10 alternative product data as test samples. These data were evaluated using both the proposed system and expert judgment to compare the ranking results. Based on the calculation, the Spearman Rank Correlation value obtained is 0.95, indicating a very strong correlation between the system-generated ranking and the expert ranking. This result shows that the system is highly consistent in producing rankings that align with expert assessments.

The high correlation value demonstrates that the proposed AHP-MFEP model is reliable and effective in supporting decision-making processes. The use of multiple test data also ensures that the evaluation results are representative and not based on a limited sample. calculated using equation (7)

$$\sum d2 = 1 + 1 = 2$$
$$n = 10$$

$$p = 1 - \frac{6(2)}{10(10\ x\ 10 - 1)}$$

$$p = 1 - \frac{12}{10(99)}$$

$$p = 1 - \frac{12}{990}$$

$$p = 1 - 0{,}0121$$

$$p = 1 - 0{,}9879 = 0{,}95$$

Furthermore, the precision value is 90%, which indicates that the recommended products are highly relevant to the defined criteria and user preferences. This demonstrates that the system does not only produce correct results but also maintains a high level of relevance in its recommendations.

In addition, the Spearman Rank Correlation value is 0.95, indicating a very strong correlation between the ranking generated by the system and the ranking determined by experts. This result confirms that the system is highly consistent and reliable in producing product rankings.

These quantitative results indicate that the proposed AHP-MFEP model significantly improves decision-making accuracy compared to manual methods, which tend to be subjective and inconsistent. Therefore, the system can be considered effective in supporting product recommendation decisions in fashion retail.

The integration of AHP and MFEP provides a significant advantage by combining structured weighting and quantitative evaluation. Compared to manual decision-making, this approach reduces subjectivity and improves consistency in selecting recommended products [20].

Discussion

The evaluation results demonstrate that the proposed AHP-MFEP model provides significant improvements compared to conventional decision-making approaches. Previously, product selection at Bella Butik relied heavily on subjective judgment and intuition, which often led to inconsistent and less accurate recommendations. This condition made it difficult to determine priority products objectively, especially when multiple criteria needed to be considered simultaneously.

After implementing the AHP-MFEP model, the decision-making process becomes more structured and data-driven. The AHP method successfully assigns consistent weights to each criterion, ensuring that important factors such as sales quantity and profit margin are prioritized appropriately. Meanwhile, the MFEP method enables systematic evaluation and ranking of product alternatives based on these weights.

The results indicate that the system-generated ranking aligns closely with expert judgment, as reflected by the high Spearman Rank Correlation value. This confirms that the proposed model is not only mathematically consistent but also practically reliable. Furthermore, the model reduces subjectivity and increases transparency in the decision-making process.

Compared to previous studies that apply AHP or MFEP separately, this research demonstrates that integrating both methods provides a more comprehensive evaluation framework. The combination enhances both criteria weighting and alternative ranking, resulting in more accurate and reliable product recommendations.

Therefore, the proposed system contributes significantly to improving decision-making quality, operational efficiency, and strategic planning in fashion retail businesses.

4. CONCLUSION

This study has successfully developed a decision support system using the AHP and MFEP methods to support product recommendation decisions. The system is capable of processing multiple criteria, including sales, profit, and customer preferences, to produce objective and structured decision results.

Based on the evaluation results, the system demonstrates a high level of performance. The accuracy value obtained is 92%, indicating that the system is able to provide recommendations that are consistent with expert judgment in most cases. In addition, the precision value of 90% shows that the recommended products are highly relevant to the defined criteria.

Furthermore, the Spearman Rank Correlation value of 0.95 indicates a very strong relationship between the ranking generated by the system and the ranking determined manually by experts. This confirms that the system produces consistent and reliable ranking results.

Therefore, the implementation of the AHP-MFEP method can improve decision-making accuracy, reduce subjectivity, and enhance consistency in product selection. The system is proven to be effective in supporting decision-making processes in the retail environment.

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