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Development of a Decision Support System Based on the Weighted Product to Optimize Production Scheduling in the Furniture Industry

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ABSTRACT

The furniture industry plays a crucial role in Indonesia's manufacturing sector, which contributed 18.98% to the national GDP in 2024 with a growth rate of 4.43%. However, increasing market demand and product variety have created significant challenges in achieving efficient and timely production scheduling. Inefficient manual scheduling processes have been shown to cause substantial delays, with approximately 31% of production orders experiencing lateness due to poor scheduling and machine utilization. This study aims to design and implement a Decision Support System (DSS) based on the Weighted Product (WP) method to objectively determine production scheduling priorities using order quantity, processing time, and profit value as key criteria. The DSS was developed using Microsoft Visual Basic 6.0 and Microsoft Office Access 2016, utilizing secondary data from a furniture manufacturing company. Validation results show that the DSS achieved a 99.998% accuracy rate compared to manual Excel calculations, indicating correct implementation of the WP computational algorithm. The system effectively enhances production planning by providing objective, data-driven scheduling recommendations, reducing delays, optimizing resource utilization, and improving operational efficiency. Overall, the DSS serves as an effective managerial tool to support decision-making consistency and competitiveness in the manufacturing industry.

INTRODUCTION

The Indonesian manufacturing sector contributed 18.98% to the national GDP in 2024, with a growth of around 4.43% (Kompas, 2024). The transformation of raw materials such as wood, rattan, and other natural materials into high value-added furniture products makes this industry the backbone of many regions in Indonesia. However, with increasing market demand and product variety, furniture companies are faced with major challenges in managing production processes efficiently and on time. According to Saputro (2016), during November 2014–February 2015, approximately 31% of production orders experienced delays due to inefficient scheduling and machine utilization.

One of the main obstacles often encountered is production priority scheduling, which is still done manually, potentially leading to wasted time, energy, and costs, as well as reducing the company's competitiveness amid increasingly fierce industry competition (Rosada & Kristianto, 2024).

Production scheduling efficiency not only affects the smooth running of the manufacturing process but also directly influences customer satisfaction and business sustainability. Suboptimal scheduling can lead to delivery delays, production backlogs, and inefficient resource utilization (Nasution et al., 2024). To overcome these issues, a data- and technology-driven approach is required to provide systematic and measurable solutions for production scheduling decision-making.

Advancements in information technology, particularly in the field of Decision Support Systems (DSS), have created new opportunities for the furniture industry to enhance production schedule management. One method considered effective for supporting multi-criteria decision-making is the Weighted Product (WP) method, which allows companies to evaluate various production schedule alternatives based on key criteria such as order quantity, processing time, and profit value by objectively calculating the weight of each criterion (Vafaei et al., 2022).

Gogos (2023) highlighted that employing scheduling approaches such as Shortest Processing Time (SPT), Campbell Dudek Smith (CDS), and Pour Heuristic can improve production efficiency and minimize delays in the furniture industry. However, most previous studies have focused on conventional multi-criteria decision-making methods such as Analytic Hierarchy Process (AHP) and Simple Additive Weighting (SAW). Few studies have integrated the Weighted Product (WP) method with a computer-based Decision Support System (DSS) specifically for furniture production scheduling, particularly one that is designed to be practical and user-friendly for industrial practitioners. This indicates a significant research gap in applying WP-based DSS models to optimize production scheduling decisions in the furniture sector.

This study contributes to the existing body of knowledge by developing and implementing a DSS using the Weighted Product (WP) method to produce an optimal and adaptive production schedule aligned with market demand dynamics. The novelty of this research lies in the integration of the WP method within a DSS framework tailored to real industrial conditions in the furniture sector, providing both theoretical advancement in multi-criteria decision modeling and practical applicability for production managers through an accessible, data-driven decision support tool.

RESEARCH METHODS

The Weighted Product (WP) method was employed as the main analytical approach in this study to support the determination of production scheduling priorities in the furniture industry. The method evaluates alternatives based on three key decision criteria: order quantity, processing time, and profit value (Rudiansyah & Saputra, 2022). These criteria were selected because they represent essential aspects of production management—balancing workload capacity, delivery timeliness, and profitability. Data were collected from a partner furniture company that provided detailed information on order types, production time, unit quantity, and corresponding profit values. Figure 1 shows the stages of the research method.

Weight Determination and Formula

The weighting of each criterion was determined using an expert judgment approach, involving structured interviews with production supervisors and managers to ensure that the assigned weights accurately reflected operational priorities and decision-making practices in the company. This approach enhances the model's validity and representativeness, as the weights are derived from practitioners' real-world experience rather than purely researcher assumptions. The WP method applies a multiplicative model in which each criterion value is raised to the power of its normalized weight. Mathematically, the preference value for each alternative AiA_iAi is calculated using the following equations (Yoon as cited in Kusumadewi et al., 2006):

$$Si = \prod_{j=1}^{n} X_{ij}^{wj}; \text{ with } i = 1,2,\ldots,m. \quad (1)$$

Where $\sum wj = 1$. wj is a positive power for benefit attributes and a negative value for cost attributes. The relative preference of each alternative is given as:

$$V_i = \frac{\prod_{j=1}^{n} x_{ij}^{wj}}{\prod_{j=1}^{n} (X_j^*)^{wj}} \text{ ; with i = 1,2,…,m.} \quad (2)$$

Data Processing and DSS Development

The raw data were normalized using the min–max scaling method to ensure comparability across criteria (Kristianto et al., 2024). After normalization, the WP method was applied to compute the relative preferences for each alternative.

The Decision Support System (DSS) was developed using Microsoft Visual Basic 6.0 as the front-end and Microsoft Access 2016 as the back-end database. These two software programs were chosen based on their ease of use, compatibility with available hardware, and suitability with the company's existing infrastructure, including the use of the Microsoft Windows 11 operating system (S. Ramadhan et al., 2021). The use of these legacy tools was technically justified due to infrastructure constraints in the partner company, where most systems still operate on Windows 7 and Windows 10 (32-bit) with limited hardware resources. Visual Basic 6.0 and Access 2016 offer compatibility, low resource requirements, and ease of integration—aligning with the concept of appropriate technology for small and medium-scale industries in Indonesia.

System Validation and Testing

The DSS was validated through two stages: black box testing and user acceptance testing (UAT). Black box testing was used to verify the functional correctness of the WP calculation algorithm, ensuring that the DSS produced outputs consistent with manual computations conducted in Microsoft Excel. Subsequently, UAT was performed with company production staff to evaluate the system's usability, decision accuracy, and practical relevance in real scheduling scenarios. These validation stages ensured both technical reliability and user satisfaction, strengthening the DSS's credibility as a decision-making tool.

Analysis and Findings

The analysis results confirmed that the DSS using the WP method generated scheduling priorities identical to those produced through manual calculations, validating the accuracy of the embedded algorithm (Mahendra et al., 2023). The implementation of the WP-based DSS enabled the company to identify the most efficient production order sequence which demonstrated the best balance between profit and processing time. The developed system thus contributes to improving production efficiency, minimizing resource waste, and supporting data-driven decision-making in the furniture industry (Tarigan, 2022).

RESULTS AND DISCUSSION

In this study, the data used was obtained from the Company and was intended to analyze and improve production scheduling. The data collected included order type, order quantity, processing time, and order due date (Saputra et al., 2023). The Weighted Product (WP) method is used as a decision-making technique by taking into account several criteria that have different weights or levels of importance.

The alternatives analyzed are the five orders below, with the criteria used being the number of orders, processing time, and order profit value (Lubis et al., 2024). A summary of the research data used is shown in Table 1.

Table 1. Research Data

Order	Order Quantity (Unit/Pcs)	Order Date	Due Date	Processing Time (Days)	Profit Value
Order 1	36	36	29/02/2024	26	20.000.000
Order 2	42	42	29/02/2024	33	18.500.000
Order 3	42	42	29/02/2024	29	19.000.000
Order 4	42	42	29/02/2024	29	20.000.000
Order 5	36	36	29/02/2024	21	21.000.000

From the data in Table 1, Order 5 achieved the highest WP score because it offered the most favorable trade-off between high profit (Rp 21,000,000) and shortest processing time (21 days). Despite having the same order date and due date as the other alternatives, its lower processing duration implies higher production efficiency and better utilization of available capacity. Additionally, its profit margin exceeded all other orders, strengthening its dominance in the weighted calculation. Therefore, when the criteria weights were applied and normalized through the WP formula, Order 5 received the highest preference value, justifying its selection as the most optimal production order.

The weighting of criteria in the WP method is shown in Table 2. The number of orders and order profit value are benefit criteria, while processing time is a cost criteria.

Table 2. The Weighting of Weighted Product (WP)

Order	Code	Weight	Normalization	Type of Criteria	Weight Value
Order Quantity	C1	7	0,4375	+	+0,4375
Processing Time	C2	4	0,25	-	-0,25
Order Value Profit	C3	5	0,3125	+	+0,3125
Total	16	16	1		

After weighting, an initial matrix was formed based on the value of each order for each criterion. Next, a final calculation was performed using the WP method to obtain the ranking value for each alternative. Table 3 shows the results of the WP method calculation.

Table 3. Weighted Product (WP) Calculation Results

Order	S Value	V Value
Order 1	406,17284	0,19250
Order 2	399,51606	0,18935
Order 3	416,08548	0,19720
Order 4	422,80872	0,20039
Order 5	465,38274	0,22056
Total	2.109,96585	1

Based on the results of the WP method calculation, the priority order for production scheduling at the Company is: Rank-1: Order 5 (Highest Ranking); Rank-2: Order 4; Rank-3: Order 3; Rank-4: Order 1; Rank-5: Order 2.

The above order indicates the orders that should be prioritized in production scheduling based on a combination of order quantity, shorter processing time, and maximum profit. This structured and systematic approach is expected to improve scheduling efficiency and Company performance (Natasya & Widaningrum, 2024).

Designing a Decision Support System (DSS)

The Decision Support System (DSS) designed in this study is a computer-based application that aims to assist the decision-making process in production scheduling at companies. This system consists of three main components, namely the Database Management System, Model Management System, and Dialog Management System (Safitri et al., 2024). These three components work in an integrated manner to facilitate communication between the system and users through an interactive interface. Figure 2 shows the configuration of the production scheduling DSS.

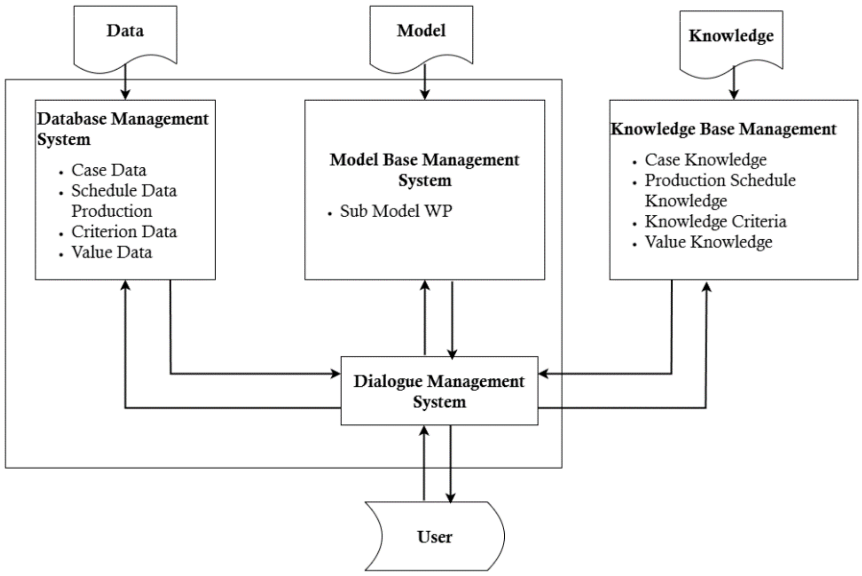

Figure 2. Production Scheduling Decision Support System (DSS) Configuration

This DSS model is intended to generate percentage values and rankings for each production schedule alternative based on the Weighted Product (WP) method. The system analyzes inputs in the form of case data, criteria, values, and alternatives, then generates outputs in the form of decision support reports (Blenski et al., 2023).

1. Dialog Management System

   The Dialog Management System acts as a link between users and the system, providing a main interface that allows users to interact with the system easily. The interface design includes the presentation of the login menu, data processing, and printing of decision results (Rahmawati et al., 2025). This user interaction component is supported by several software diagrams, namely:
   - Context Diagram: Shows the external relationship between users and the system.
   - Decomposition Diagram: Describes the main processes that are decomposed into sub-processes.
   - Event Response Table: Presents events and responses to user actions.
   - Event Handler Table: Explains the relationships between processes, actors, events, triggers, and outputs.
   - Event Diagram: Displays the process flow based on events triggered by users, such as login, case data processing, result printing, and WP method calculation (Safwandi, 2021).
2. Database Management System

   At this stage, a database is designed to store all relevant data in the DSS system. The design stages include:
   - Entity Relationship Diagram (ERD): Shows the relationships between entities such as Cases, Alternatives, Criteria, and Values. The relationships used are many-to-many, given the varying combinations of alternatives and criteria for each case. Figure 3 shows the ERD of the WP method DSS (Akbar et al., 2025).

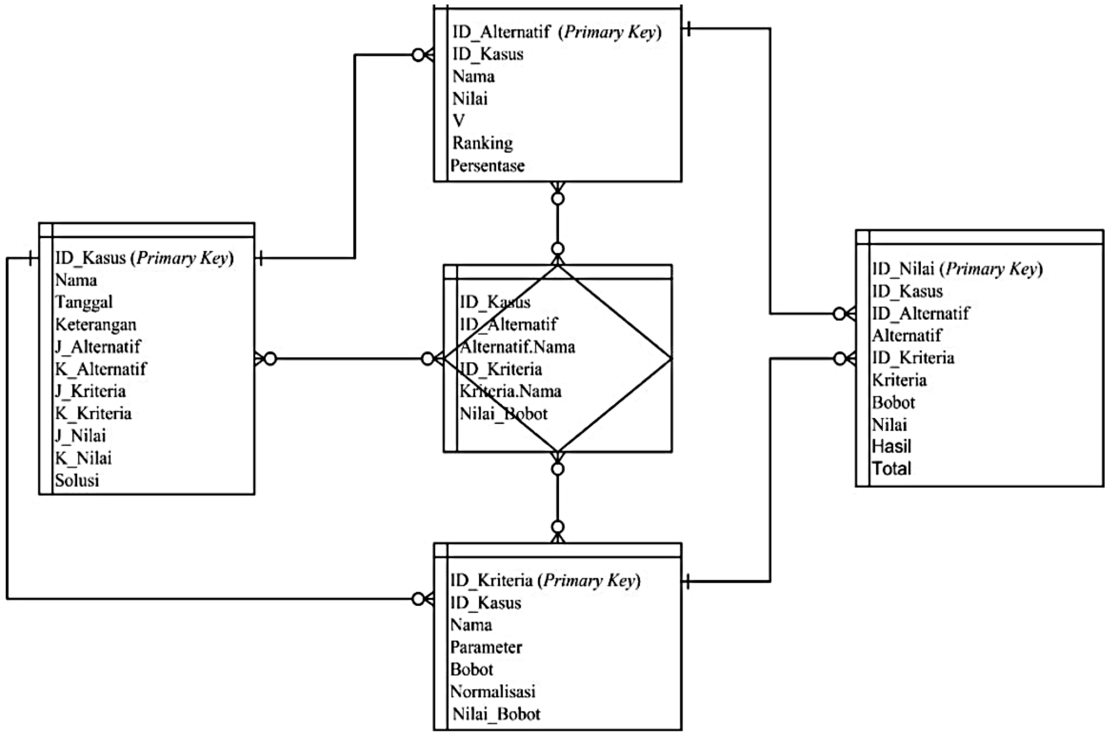

Figure 3. ERD from DSS of WP Method

The Entity Relationship Diagram (ERD) illustrates the structural relationships among five primary entities within the Decision Support System (DSS) based on the Weighted Product (WP) method, namely Kasus, Alternatif, Kriteria, Nilai, and the associative entity connecting them. The Kasus entity serves as the central component of the system, functioning as the parent entity that links to all others. It contains essential attributes such as case name, date, number of alternatives, number of criteria, and the final solution. Each Kasus is associated with multiple Alternatif entities, which represent the decision options being evaluated. The Alternatif entity stores attributes including name, value, ranking, and percentage, and maintains a one-to-many relationship with the Kasus, reflecting that each case can involve several alternatives.

The Kriteria entity defines the parameters and weighting factors used to assess each alternative. It has a one-to-many relationship with the Kasus, meaning that each case may employ multiple criteria for evaluation. The Nilai entity functions as a transactional or bridge table connecting Alternatif and Kriteria under a specific Kasus, containing key attributes such as weight, score, result, and total. This relational structure enables the system to compute normalized scores and weighted preferences for each alternative based on its associated criteria. Overall, the ERD design ensures data consistency and referential integrity, supporting efficient computation and Physical Database Design: Designed with strict consideration of the interrelationships between entities through the use of foreign keys. Deletion of case data will automatically delete all related alternative data, criteria, and values to prevent data inconsistency and confusion (Febrianto et al., 2023). Figure 3 shows the database design of the WP method DSS.

3. Model-Based Management System

The Model-Based Management System is where the calculation algorithm is run, specifically the Weighted Product (WP) method used in this study. Its application model is explained through a flowchart that illustrates the process steps, starting from criterion weighting, value normalization, to alternative ranking (Handrianto & Sanjaya, 2020). The WP method was chosen for its ability to provide decisions based on the weighting of criteria that have different values according to predetermined levels of importance.

4. Knowledge Management System
   The Knowledge Management System in this DSS includes information from both the external environment (e.g., government policies or market needs) and within the company. This knowledge serves as a reference in determining relevant criteria in each evaluation period. However, at this stage of research, the knowledge management system has not been discussed in depth because its development is left to the Company (Rinaldi, 2023). Determining criteria and their importance in the future will be more effective if done by management who has better domain knowledge. With the design of this structured decision support system, it is hoped that the production scheduling process at the company can be carried out more objectively, efficiently, and measurably, taking into account various criteria relevant to its business processes (Anugraha et al., 2023).

System Implementation

The WP Method DSS was implemented with various interfaces representing each major business process related to production scheduling decision making (Ardiansyah et al., 2024). Figure 5 shows the result of WP method DSS interface display.

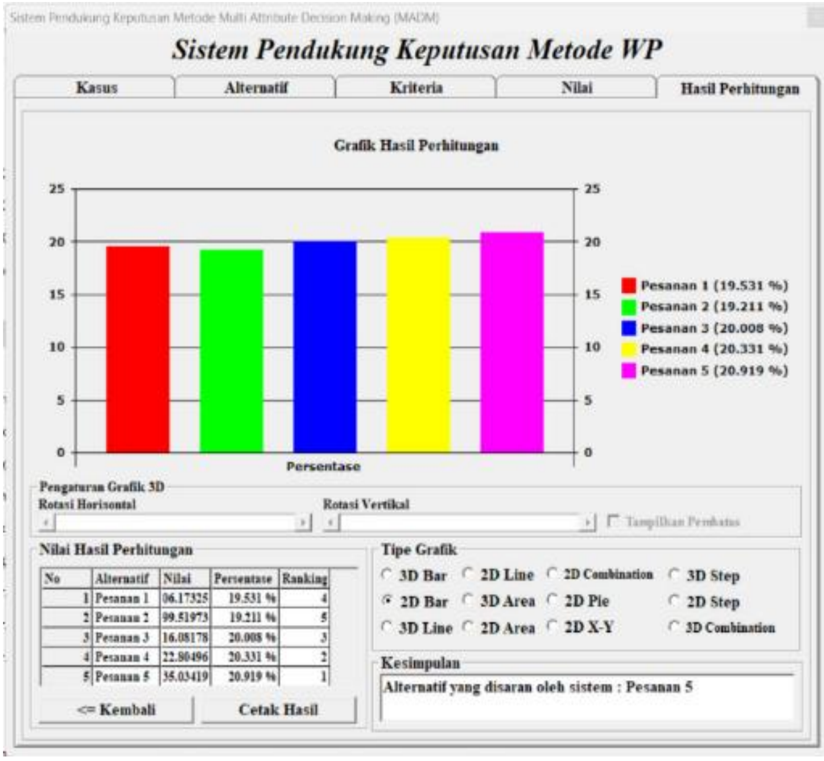

Figure 5. the result of WP method DSS interface display

The simulation results of the Decision Support System (DSS) using the Weighted Product (WP) method demonstrate the system's capability to objectively evaluate multiple alternatives based on predetermined criteria weights. Each alternative, representing a production order, was assessed through a multiplicative aggregation process, where criterion scores were raised to the power of their respective weights. The computed preference values indicate that Order 5 achieved the highest score of 0.242554 (21.28%), followed by Order 2 with 0.220851 (20.05%), Order 3 with 0.218226 (19.81%), Order 1 with 0.215321 (19.53%), and Order 4 with 0.213047 (19.33%). These results reveal that Order 5 is the most optimal choice according to the WP decision model, reflecting its superior performance across all evaluation criteria.

The bar chart visualization reinforces the numerical findings by illustrating the comparative performance of each alternative, with *Order 5* clearly exhibiting the highest preference percentage. This indicates that the DSS successfully applies the WP method to differentiate alternatives based on their relative importance and criterion satisfaction levels. The results confirm that the WP-based decision model is effective in ranking alternatives with minimal computational bias, offering a transparent and reliable tool for multi-criteria decision-making in production order selection.

System Integration

The developed Weighted Product (WP) Method Decision Support System (DSS) was successfully implemented with integrated modules and interfaces designed according to system requirements, covering processes such as login, user management, production data entry, and decision processing to ensure security, usability, and effective data management (Zulman et al., 2025). The system's compatibility with the company's existing infrastructure allows optimal operation without significant hardware upgrades, while all core features have been tested and proven to function effectively in supporting multi-criteria production scheduling (Muin, 2025). Overall, the structured design and implementation of the WP-based DSS enhance decision-making efficiency, data accuracy, and system security, providing a reliable technological solution for production scheduling in dynamic industrial environments.

Testing Result

Based on the comparative testing across all eleven test scenarios presented in Table 5, the Decision Support System (DSS) demonstrated an overall accuracy level (average match level)of 99.998% when compared with manual calculations in Microsoft Excel. This percentage was obtained by analyzing the similarity of ranking outcomes and the difference in percentage values (P%) between both calculation methods. The negligible deviations, which were primarily caused by rounding differences at the fourth decimal place, indicate that the DSS's computational logic has been successfully implemented in accordance with the mathematical principles of the WP methods. From a design perspective, the DSS can be categorized as functionally robust and reliable. It accurately reproduces manual calculations, executes multi-criteria evaluations effectively, and provides clear, consistent output for decision-making. However, some areas for improvement remain.

Table 5. Testing Result

NO	Description	Total Performance	Alternatif	WP				Match Level	Valid/Not Valid
				EXCEL		SPK			
				P (%)	R	P (%)	R		
1.	Testing-1	2	A	50.044	1	50.044	1	100%	Valid
			B	49.956	2	49.956	2	100%	Valid
2.	Testing-2	2	A	25.384	3	25.384	3	100%	Valid
			B	46.635	1	46.635	1	100%	Valid
			C	27.981	2	27.981	2	100%	Valid
…	…	…	…	…	…	…	…	…	…
10.	Testing-10	5	A	13.326	6	13.326	6	100%	Valid
			B	19.934	2	19.934	2	100%	Valid
			C	14.520	4	14.52	4	100%	Valid
			D	18.108	3	18.107	3	99,995%	Valid
			E	14.048	5	14.048	5	100%	Valid
			F	20.064	1	20.065	1	99,995%	Valid

CONCLUSION

This study successfully developed and implemented a Decision Support System (DSS) based on the Weighted Product (WP) method to optimize production scheduling in the furniture industry. By evaluating multiple criteria, namely order quantity, processing time, and profit value, the WP-based DSS enables objective and data-driven decision-making, resulting in more efficient, timely, and adaptive production schedules aligned with market dynamics. Testing on actual company data demonstrated that the system effectively provides optimal production priorities while minimizing delays and resource inefficiencies. Comparative testing with manual Excel calculations achieved an accuracy rate of 99.998%, confirming the system's computational precision and reliability.

Overall, the developed DSS proved to be functionally robust, accurate, and user-friendly, allowing production managers to manage data and make structured scheduling decisions with greater ease. The system contributes significantly to improving production efficiency and accelerating the decision-making process, providing an innovative and practical tool for achieving sustainable, data-driven production management in the furniture sector.

Future development should focus on enhancing user interface usability, integrating real-time data input to reduce manual entry, and developing dynamic weight adjustment features that allow users to modify criterion weights interactively. Additionally, implementing database automation and web-based access could improve scalability and make the DSS more adaptable for industrial applications. Overall, the current DSS design can be considered both accurate and practical, providing a strong foundation for further intelligent decision support development.

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