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Decision Support System for Asset Management using the Simple Additive Weighting Method

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Abstract
Effective and efficient asset management is a crucial aspect in supporting the operational sustainability of an organization. However, the decision-making process in determining whether an asset should be retained, repaired, or replaced is often conducted subjectively and lacks structure. This study aims to develop a Decision Support System (DSS) for asset management using the Simple Additive Weighting method to assist in evaluating assets objectively based on multiple criteria. The developed system includes features such as a master data menu, alternative data input, SAW-based calculation processes, and a recommendation result display. System testing results showed that the values for accuracy, precision, recall, and specificity were each 80%, with 4 True Positive, 4 True Negative, 1 False Positive, and 1 False Negative. Based on these results, the system is considered valid and suitable for use as a decision-making tool in structured and measurable asset management processes. This level of accuracy also reflects the system's ability to accurately identify and classify data under both positive and negative conditions. Therefore, it can be concluded that this decision support system has a good level of reliability and is suitable for use as a supporting tool in asset management decision-making.

Keywords:
Decision Support System; Asset Management; SAW Method.

1. INTRODUCTION

Assets are vital components in the operations of an organization. Whether in the form of movable goods (vehicles, equipment, machinery) or immovable properties (land, buildings), assets serve as resources that support the achievement of strategic goals. Therefore, effective and efficient asset management is essential to maximize their utility and economic lifespan. However, field realities show that decision-making in asset management often faces various challenges, such as limited information, the lack of objective assessment methods, and the dominance of subjective decisions by individuals or asset managers.

In many cases, organizations struggle to determine which assets should be prioritized for maintenance, utilization, replacement, or disposal due to the absence of a supporting system capable of accommodating multiple evaluation criteria simultaneously (Do & Jung, 2018). This issue leads to suboptimal asset utilization, increased operational costs, and a higher risk of losses caused by poor decision-making. Therefore, a systematic approach is needed through a Decision Support System (DSS) (Gibbin et al., 2023). A DSS can assist decision-makers in addressing semi-structured problems by processing various alternatives based on predetermined criteria. (Veza & Arifin, 2020).

One of the most widely used methods in multi-criteria decision-making is Simple Additive Weighting (SAW). The SAW method is well-known for its simplicity in application and its accuracy in producing the best alternative based on the weighted summation of criteria values (Popy Yolita Clara Banamtuan et al., 2024). Through the integration of a Decision Support System (DSS) and the Simple Additive Weighting (SAW) method, the asset management process can be carried out in a more measurable, objective, and transparent manner (Al-Kasasbeh et al., 2021). This system is capable of considering various parameters such as asset age, usage frequency, maintenance costs, residual value, and urgency of need. Thus, the resulting decisions are not only time- and cost-efficient but also based on a strong and logical foundation.

The Simple Additive Weighting (SAW) method is one of the most widely used Multi-Criteria Decision Making (MCDM) methods in the development of decision support systems (Youssef & Saleem, 2023). This method is known for its simplicity in calculation and its ability to provide a ranking of alternatives based on the weighted summation of each criterion. According to (Norida, 2018), the SAW method allows decision makers to select the best alternative from a set of options based on the weighted values of each relevant criterion (Abdullah et al., 2022). The normalization and weighting processes in the SAW method make it well-suited for application in decision-making contexts that require consideration of multiple aspects, such as in asset management (Leipary et al., 2024).

Research by (Tian et al., 2022) demonstrated that the SAW method can be effectively applied in a decision support system for selecting outstanding students. In that study, several criteria such as academic scores, organizational involvement, and non-academic achievements were evaluated using the SAW method, which then produced an objective ranking of students. This indicates that SAW can be used in various decision-making contexts that require the simultaneous and balanced assessment of multiple criteria. The successful implementation of SAW in this study reinforces that the method can be adapted to other domains, including asset management, which also involves multiple criteria such as asset age, physical condition, economic value, and maintenance costs.

Research by (Hariski et al., 2023) demonstrated the application of the SAW method in selecting locations for infrastructure development. The study formulated several criteria such as accessibility, construction costs, and environmental impact, which were then processed through a web-based system using the SAW method. The results showed that this method is capable of accurately managing quantitative data and producing outputs that are logically accountable. The application of SAW in this spatial and managerial context illustrates the method’s high flexibility across various decision-making fields, including asset management, which also requires consideration of factors such as location, cost, and urgency.

In the specific context of asset management, (Prana & Hidayat, 2022a) highlighted the challenges in managing regional assets, where decision-making processes remain manual and lack transparency. They proposed the implementation of a decision support system based on quantitative methods such as SAW to enhance efficiency and accountability in the process. The proposed system aims to reduce subjective bias and assist stakeholders in prioritizing asset management decisions. This study reinforces the urgency of digitalizing and systematizing decision-making processes in the management of public or organizational assets.

Several previous studies, as highlighted by (Prana & Hidayat, 2022b) affirm that the Simple Additive Weighting (SAW) method is effective in selecting the best alternative through a structured and weighted evaluation process. This method offers a systematic approach to processing a range of alternatives based on criteria that have been assigned weights according to their level of importance, thereby producing a fair and logical ranking of alternatives. In the context of asset procurement, the SAW method has proven to support the evaluation process for selecting tender winners more objectively and accurately, as it considers both benefit aspects such as quality, technical specifications, and added value and cost aspects such as price and spending efficiency. This method of evaluation reduces subjectivity in decision-making and provides a rational basis for the selection process, which is particularly important in the procurement of goods and services within higher education institutions.

However, despite the proven effectiveness of the SAW method in various procurement and selection contexts, a significant gap remains in its practical implementation for broader asset management tasks beyond procurement, particularly within public sector organizations. The main problem lies in the fact that many institutions still rely on manual, unstandardized, and often subjective approaches in evaluating asset conditions and determining asset priorities resulting in inefficiencies, inconsistencies, and a lack of accountability in decision-making processes. Additionally, there is limited integration between existing asset databases and decision-support mechanisms, which hampers the optimization of asset utilization and long-term planning.

This study contributes to addressing these gaps by developing a comprehensive Decision Support System (DSS) for asset management that operationalizes the SAW method in a digital environment. Unlike previous works that primarily focus on SAW for procurement selection, this research applies SAW to the ongoing management and evaluation of organizational assets, such as determining which assets should be maintained, replaced, or prioritized based on multi-criteria assessment. By automating the evaluation process and structuring it through clearly defined weights and criteria, the system enhances objectivity, transparency, and efficiency in asset-related decisions. Thus, the study not only reaffirms the utility of SAW but also extends its application scope, offering a practical tool that can be adopted by public institutions or organizations to modernize and rationalize their asset management practices.

2. RESEARCH METHOD

The development of the decision support system was carried out using the Linear Sequential Model (LSM). This model is a design framework structured in a systematic and sequential manner (Prawirayuda et al., 2022). It consists of five main stages: requirements analysis, design, implementation, testing, and maintenance (Hidayatun et al., 2020). Each stage is conducted in order to ensure that every step in the system development process is executed carefully and in a well coordinated manner (Hidayatun et al., 2020). The stages involved in system development using the LSM method are as follows:

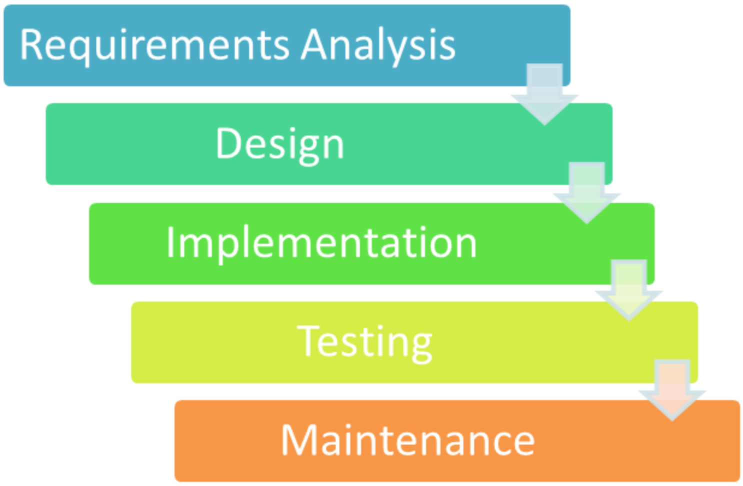


Figure 1. Research Method Using the Linear Sequential Model (LSM)

This research begins with the requirement analysis stage, where the researcher identifies existing problems in the asset management process within the relevant institution. Based on observations and interviews, it was found that the decision-making process in determining asset priorities—whether to retain, repair, or replace assets—was still subjective and not yet supported by a structured system. Therefore, a decision support system is needed to objectively assess assets based on several criteria, such as asset age, physical condition, economic value, and frequency of use. The need for such a system serves as the foundation for designing an appropriate and measurable solution.

Once the system requirements are identified, the next stage is system design, which involves designing the logical structure of the SAW method calculation, the user interface, and the data model used to store asset information and criteria weights. At this stage, the decision-making workflow based on the SAW method is also designed, from data input, normalization, and weighting, to the final result in the form of asset eligibility rankings. The system is designed to be simple yet functional, making it easy for management to use in evaluation and decision-making processes.

The next stage is implementation, which involves translating the system design into a functional application. The system is developed using appropriate programming languages and databases, with the SAW method logic integrated into the system to perform automatic calculations. During this stage, features such as asset data input, criteria weight assignment, final score calculation, and output display of asset rankings are developed and internally tested using simulated data.

After the implementation is complete, the testing stage is conducted to ensure the system functions as expected. Testing is carried out functionally using the black box testing approach, where each feature is tested from the user's perspective without examining the source code. Various test scenarios are prepared to evaluate the system’s responses to different inputs and to validate the accuracy of the SAW method calculations. In addition, potential users are involved in testing to assess the system’s usability and the clarity of the displayed results.

The final stage is maintenance, carried out after the system is actively in use. Maintenance aims to ensure the system continues to operate properly over time and can be adjusted if there are changes in evaluation criteria, organizational structure, or asset management policies. This process also includes bug fixes, data updates, and further development if needed. With this maintenance stage, it is expected that the SAW-based decision support system for asset management can be used sustainably and continue to provide optimal benefits for the organization.

3. RESULTS AND DISCUSSION

3.1. Simple Additive Weighting (SAW) Calculation

To illustrate the workflow of the system designed in this study, a flowchart is used as a visual representation of the processes within the asset management decision support system based on the Simple Additive Weighting (SAW) method. This flowchart outlines the main steps carried out, starting from asset data input, assigning weights to criteria, calculation process, and presenting the evaluation results in the form of a ranking. The use of the flowchart is intended to help readers gain a clearer understanding of how the system operates as a whole and how the SAW method is applied in the decision-making process. The flowchart of the system is shown in the following figure:

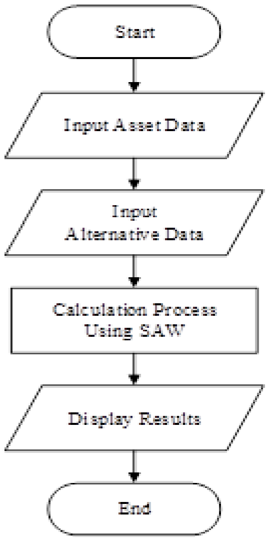


Figure 2. Flowchart of the Asset Management Decision Support System Using the SAW Method

The diagram above illustrates the workflow of the asset management decision support system using the Simple Additive Weighting (SAW) method, which is systematically arranged from the input process to the presentation of evaluation results. The process begins with the initial stage, where the user accesses the system to assess the assets to be analyzed. In the next stage, the user inputs asset data, including information such as asset name, age, physical condition, economic value, and frequency of use. After that, the user is required to input the weight for each criterion according to its level of importance, allowing the system to proportionally consider each assessment aspect. The entered data then undergo a normalization process, aimed at equalizing the scales among criteria so they can be fairly compared. Subsequently, the system calculates the final score for each asset using the SAW method, by summing the multiplication results between the normalized values and the corresponding criterion weights. Based on these final scores, the system ranks all evaluated assets to determine which ones are most eligible to be managed or prioritized. The calculation results and asset rankings are then displayed in table or visualization form to the user as a basis for decision-making. The process concludes after the system presents a comprehensive evaluation output, which can then be used by management to determine policies regarding the organization's assets. This flowchart serves as a logical representation of the processes within the decision support system, designed to facilitate objective, measurable, and efficient asset management.

3.2. System Implementation

System implementation is carried out as a realization of the previously conducted needs analysis and system design. This system is designed to assist the decision-making process in asset management in an objective, measurable, and efficient manner. The main focus of this implementation is to integrate the Simple Additive Weighting (SAW) method into a computer-based system capable of managing asset data, performing score calculations based on predefined criteria, and presenting evaluation results in the form of rankings. With this system, users can easily determine which assets should be retained, repaired, or replaced based on the final scores generated. This section presents the system's user interface, the data input process, the automatic SAW-based calculations, and the output results as evidence that the system operates in accordance with the research objectives.

3.2.1. Admin Login Page

The Login page serves as the entry point for system administrators to access and manage the Decision Support System. It is equipped with essential components, including input fields for entering the username and password, along with a Login button to proceed with authentication. This page is designed with a simple and user-friendly interface to ensure ease of access and security. Users must provide valid credentials to gain authorized access to the system's features. The visual appearance of the Login page is illustrated in the following figure:

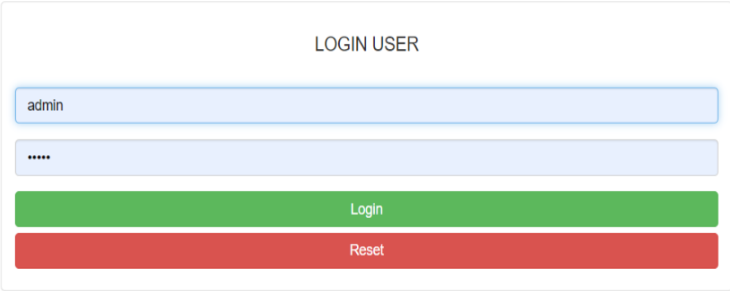


Figure 3. Login Page Display

3.2.2. Admin Main Page

The Admin Main Page features several navigation menus designed to facilitate system management and decision-making processes. These include the Home menu, a Master Data section (consisting of Master User, Master Criteria Weights, and Master Asset/Customer Data), and the SAW Process section (which includes Set Alternative Values, SAW Calculation, and Recommendation Results). Additionally, there is a Logout option to securely exit the system. Each of these menus plays a specific role in managing data input, processing, and result presentation within the Decision Support System. The layout of the Admin Main Page is shown in the following figure:

Figure 4. Main Page Display

3.2.3. Master User Page

The Master User Page includes several key functions to manage user data within the system. These functions consist of viewing user records, adding new users, updating existing user information, and deleting user entries as needed. This page is designed to ensure that user management is conducted efficiently and securely by administrators. All user data is displayed in a structured table format for clarity and ease of access. The interface also allows for seamless editing and maintenance of user records to support the overall integrity of the system. The appearance of the Master User Page is shown in the following figure:

Figure 5. Master User Page Display

3.2.4. Criteria Weight Master Page

The Criteria Weight Master Page provides several essential features for managing the weights assigned to each decision criterion. These features include viewing existing data, adding new criteria weights, updating current values, and deleting criteria weights when necessary. Only users with administrative privileges are authorized to perform additions or modifications to the criteria weights, ensuring data consistency and decision integrity. This page plays a crucial role in determining the influence of each criterion during the SAW calculation process, as the assigned weights directly impact the final ranking results. The layout of the Criteria Weight Master Page is shown in the following figure:

Figure 6. Criteria Weight Master Page Display

3.2.5. Asset Master Data Page

The Asset Master Data Page provides several key functionalities for managing asset records within the system. These include options to view existing asset data, add new assets, update asset information, and delete asset entries as needed. This page serves as a central hub for organizing and maintaining comprehensive details about each asset, such as asset name, age, condition, economic value, and usage frequency. Proper management of asset data is essential to ensure accurate analysis and recommendations during the decision-making process. The interface is designed to be intuitive and user-friendly, allowing administrators to manage data efficiently. The appearance of the Asset Master Data Page is shown in the following figure:

Figure 7. Asset Master Data Page Display

3.2.6. Set Alternative Data Page

The Set Alternative Data Page contains a feature that allows administrators to input and manage the alternative values for each customer or asset based on the predefined decision criteria. This page is essential for assigning individual scores to each criterion such as asset age, condition, economic value, or usage frequency—which will later be used in the SAW calculation process. Each entry represents how an alternative (such as an asset or user) performs against each criterion. Accurate data input at this stage is crucial, as it directly influences the final recommendation results. The interface is designed for ease of use, enabling users to enter and update data efficiently. The display of the Set Alternative Data Page is shown in the following figure:

SISTEM PENUNJANG KEPUTUSAN
PENGELOLAAN ASET

SPK Menu | Home | Master Data | SAW Proses | Logout

Set Data Alternatif

No	Nomor Aset	Nama Aset	Tingkat Kerusakan	Jumlah Penyusutan Aset	Jumlah Hari Penggunaan	Action
1	MJB002	Meja B002	10	100	2000	
2	KA001	Komputer Acer 01	60	25	1000	
3	PR002	Proyektor 02	100	100	365	
4	PR003	Proyektor 03	80	50	400	
5	MR001	Monitor Ruang 01	60	50	367	
6	MJB005	Meja B005	60	100	365	
7	PTR01	Papan Tulis Ruang 01	100	100	365	

Halaman : 1

Figure 8. Set Alternative Data Page Display

3.2.7. SAW Calculation Page

The SAW Calculation Page features a menu that allows users to view the results of the decision support calculations using the Simple Additive Weighting (SAW) method. This page plays a central role in the system by displaying the outcome of the evaluation process after all alternatives have been scored and weighted according to the predefined criteria. The system automatically performs normalization, applies the respective weights, and generates a final score for each alternative. These scores are used to determine the ranking or prioritization of assets or decisions. The page is designed to present the results clearly and transparently, enabling decision-makers to interpret and act on the information effectively. The interface of the SAW Calculation Page is shown in the following figure:

SISTEM PENUNJANG KEPUTUSAN
PENGELOLAAN ASET

SPK Menu | Home | Master Data | SAW Proses | Logout

Normalisasi Bobot Kriteria (Ri = Xij / MAXij)

No	Nama Aset	No Aset	Nilai R1	Nilai R2	Nilai R3
1	Meja B002	MJB002	0.100	1.000	1.000
2	Komputer Acer 01	KA001	0.600	0.250	0.500
3	Proyektor 02	PR002	1.000	1.000	0.183
4	Proyektor 03	PR003	0.800	0.500	0.200
5	Monitor Ruang 01	MR001	0.600	0.500	0.184
6	Meja B005	MJB005	0.600	1.000	0.183
7	Papan Tulis Ruang 01	PTR01	1.000	1.000	0.183

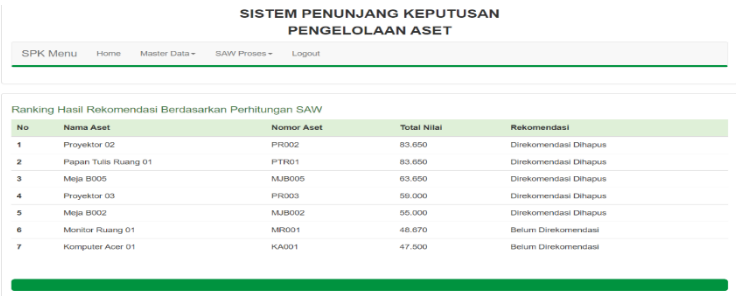
Nilai Vector Bobot (Vi = Wj x Rij)

No	Nama Nasabah	NIK	Nilai V1	Nilai V2	Nilai V3	Total Nilai
1	Meja B002	MJB002	5.000	30.000	20.000	55.000
2	Komputer Acer 01	KA001	30.000	7.500	10.000	47.500
3	Proyektor 02	PR002	50.000	30.000	3.650	83.650
4	Proyektor 03	PR003	40.000	15.000	4.000	59.000
5	Monitor Ruang 01	MR001	30.000	15.000	3.670	48.670
6	Meja B005	MJB005	30.000	30.000	3.650	63.650
7	Papan Tulis Ruang 01	PTR01	50.000	30.000	3.650	83.650

Figure 9. SAW Calculation Page Display

3.2.8. Recommendation Result Page

The Recommendation Result Page provides a feature to display the final recommendations generated from the SAW (Simple Additive Weighting) calculation process. This page serves as the final output of the decision support system, presenting a list of alternatives such as assets or customers ranked based on their total scores derived from the weighted criteria. The recommendations shown help decision-makers easily identify which alternatives are the most suitable for action, such as prioritizing for maintenance, replacement, or further evaluation. The layout of the Recommendation Result Page is designed to be clear, informative, and easy to interpret, supporting transparent and evidence-based decision-making. The appearance of this page is shown in the following figure:



SISTEM PENUNJANG KEPUTUSAN
PENGELOLAAN ASET

SPK Menu | Home | Master Data | SAW Proses | Logout

Ranking Hasil Rekomendasi Berdasarkan Perhitungan SAW

No	Nama Aset	Nomor Aset	Total Nilai	Rekomendasi
1	Proyektor 02	PR002	83.650	Direkomendasi Dihapus
2	Papan Tulis Ruang 01	PTR01	83.650	Direkomendasi Dihapus
3	Meja B005	MJB005	63.650	Direkomendasi Dihapus
4	Proyektor 03	PR003	59.000	Direkomendasi Dihapus
5	Meja B002	MJB002	55.000	Direkomendasi Dihapus
6	Monitor Ruang 01	MR001	48.670	Belum Direkomendasi
7	Komputer Acer 01	KA001	47.500	Belum Direkomendasi

Figure 10. Recommendation Result Page Display

3.3. Accuracy, Precision, Recall, and Specificity Testing

Accuracy, precision, recall, and specificity testing is conducted to evaluate the performance of the developed decision support system, particularly in terms of the system's ability to produce correct and relevant decisions based on the given data. This testing involves comparing the system's output with validation data or reference data that has been previously established as ground truth. To determine the system's accuracy, precision, recall, and specificity, the following formulas are used:

$$Accuracy = \frac{(TP+TN)}{(TP+TN+FP+FN)} \quad (1)$$

$$Precision = \frac{(TP)}{(TP+FP)} \quad (2)$$

$$Recall = \frac{(TP)}{(TP+FN)} \quad (3)$$

$$Specificity = \frac{(TN)}{(TN+FP)} \quad (4)$$

In decision support system testing, four key indicators commonly used in the confusion matrix concept are applied: True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN). True Positive (TP) refers to the condition where both the decision support system and the expert evaluation indicate that a data item falls into the "Recommended" category. True Negative (TN) occurs when both the system and the expert agree that the data is "Not Recommended". False Positive (FP) is when the expert classifies the data as "Recommended", but the system marks it as "Not Recommended". Conversely, False Negative (FN) arises when the expert determines the data is "Not Recommended", but the system categorizes it as "Recommended". These four parameters form the basis for calculating the system's accuracy, precision, recall, and specificity, which are essential to determine how well the system aligns with expert judgment in making correct and relevant decisions.

In the accuracy test, the system's results are compared with the expert's (asset officer's) decisions. The data used consists of 10 records from customers: 5 categorized as "Recommended" and 5 as "Not Recommended". The outcomes for TP, TN, FP, and FN are summarized in the following table:

Table 1. Accuracy, Precision, Recall, and Specificity Testing

Test Data	Expert Results	DSS Results	TP	TN	FP	FN
Asset 1	Recommended	Recommended	1	0	0	0
Asset 2	Recommended	Not Yet Recommended	0	0	1	0
Asset 3	Recommended	Recommended	1	0	0	0
Asset 4	Recommended	Recommended	1	0	0	0
Asset 5	Recommended	Recommended	1	0	0	0
Asset 6	Not Yet Recommended	Not Yet Recommended	0	1	0	0
Asset 7	Not Yet Recommended	Not Yet Recommended	0	1	0	0
Asset 8	Not Yet Recommended	Not Yet Recommended	0	0	0	1
Asset 9	Not Yet Recommended	Not Yet Recommended	0	1	0	0
Asset 10	Not Yet Recommended	Not Yet Recommended	0	1	0	0

Based on the results of the system validation test, which compares the output of the decision support system with expert assessments, a True Positive (TP) value of 4 was obtained, indicating that there are 4 data entries recommended by both the system and the expert. Furthermore, the True Negative (TN) value is also 4, meaning that both the system and the expert agreed that 4 data entries should not be recommended. The False Positive (FP) value of 1 shows a case where the system did not recommend a data entry, while the expert considered it should have been recommended. Meanwhile, the False Negative (FN) value is also 1, which occurred when the system recommended a data entry that the expert did not. These values are then used in the formulas for calculating accuracy, precision, recall, and specificity, to quantitatively evaluate the system's performance. The accuracy calculation result is presented as follows:

Table 2. Accuracy, Precision, Recall, and Specificity Test Results

Test	Results
Accuracy	80 %
Precision	80 %
Recall	80 %
Specificity	80 %

Based on the testing results for accuracy, precision, recall, and specificity of the Asset Management Decision Support System developed using the Simple Additive Weighting (SAW) method, a consistent evaluation outcome was obtained, where all four metrics produced the same value of 80%. This result indicates that the system is capable of providing decisions aligned with expert assessments in 80% of cases both in recommending and not recommending an asset. This level of accuracy also reflects the system's ability to correctly identify and classify data under both positive and negative conditions. Moreover, the equal values between precision and recall demonstrate that the system is not only accurate in making recommendations but also sufficiently sensitive in detecting assets that are truly eligible. Therefore, it can be concluded that this decision support system has a good level of reliability and is feasible to be used as a supporting tool in asset management decision-making. It can also be considered valid in the context of its application.

To further enhance the performance and adaptability of this decision support system, future improvements could include the integration of Artificial Intelligence (AI) or machine learning models. Unlike the deterministic nature of the SAW method, AI and machine learning can learn from historical asset data, usage trends, and contextual factors to detect more complex patterns and provide predictive insights. For example, supervised learning algorithms such as Random Forest or Support Vector Machines (SVM) could be trained to classify assets with higher accuracy, while deep learning models might help uncover hidden relationships in multidimensional datasets. Additionally, incorporating AI can allow the system to continuously improve over time by adapting to new data and evolving decision-making criteria. This enhancement would not only increase the precision and reliability of the recommendations but also support more nuanced, data-driven decisions that go beyond fixed weighted criteria. Therefore, the integration of AI technologies holds promising potential to elevate the system from a static decision support tool to a more intelligent and adaptive decision-making assistant in asset management.

4. CONCLUSION

Based on the results of the discussion and system implementation, it can be concluded that this research has successfully developed a Decision Support System for Asset Management using the Simple Additive Weighting (SAW) method, which performs well with 80% accuracy, precision, recall, and specificity. The system includes core components such as master data management, alternative input, SAW-based calculations, and recommendation output, making it a valid and reliable tool for supporting asset-related decisions. For future development, it is recommended to integrate Artificial Intelligence (AI) or machine learning models to enable the system to learn from historical data, identify complex patterns, and provide more adaptive, predictive, and data-driven recommendations thereby enhancing its effectiveness in dynamic asset management environments.

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