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Decision Support System For Rewarding The Best Customers Of Shariah Waste Bank UINSA Surabaya Using SAW Method

[1]Muhammad Chaidar Aqsa Barpasya, [2]Ahmad Habib
Informatics, Engineering
University 17 Agustus1945 Surabaya, Surabaya, Indonesia
[1]mchaidar.abarpasya@gmail.com, [2]habib@untag-sby.ac.id

Abstract— Shariah Waste Bank of UINSA Surabaya, as a cooperative institution with a Shariah approach to waste management, focuses primarily on environmental sustainability and encourages the community to love and utilize waste as an economic commodity. Playing a significant role in addressing waste issues on campus and its surroundings, this bank contributes to cleanliness, environmental awareness, adds economic value from waste, and enhances community creativity. Providing rewards to the best customers is an innovation to boost spirits and active participation, aligning with the institution's vision and mission. However, challenges arise due to the lack of an organized structure for evaluation criteria, making it difficult to identify the best customers objectively. Information technology is needed through a decision support system using the Simple Additive Weighting (SAW) method to overcome this. The research results indicate that the application of the SAW method in this decision support system successfully assists Bank Sampah Syariah UINSA Surabaya in determining the best customers based on criteria such as the Number of Transactions, Total Revenue, Waste Value, Active Duration, and Waste Weight. Black box testing with 50 test cases confirms that the system meets all functional requirements and operates reliably. System testing demonstrates that the SAW method provides an objective basis for awarding customers, promotes transparency, and enhances decision making efficiency.

Keywords— Decision Support System, Rewarding, Simple Additive Weighting.

I. INTRODUCTION

The Shariah Waste Bank of UINSA Surabaya, as a cooperative institution with a Shariah approach, is engaged in waste management. In its operations, the bank focuses on environmental sustainability and encourages the community to love the environment and utilize waste as an economic resource. With a vision to create a clean and green environment through cooperative management, the waste bank carries out its mission by promoting environmental awareness and utilizing waste as an economic source.

The Shariah Waste Bank of UINSA Surabaya plays a significant role in addressing waste issues on campus and its surroundings, contributing to cleanliness, environmental awareness, the added economic value of waste, and enhancing community creativity. In managing the waste bank, customers play a crucial role as active participants in the waste collection and management process.

Providing rewards or awards to the best customers is an innovation aimed at increasing enthusiasm and active participation among them, as well as the waste bank's efforts to achieve its vision and mission. The reward is a form of appreciation for the positive contribution of customers in maintaining environmental cleanliness, supporting the economic value of waste, and stimulating increased creativity in waste management.

However, the need for an organized structure in determining the evaluation criteria makes the process of identifying the best customers difficult to carry out objectively. To address this problem, several criteria need to be considered in making a

decision. The use of information technology in the form of a decision support system is necessary to make the evaluation process more effective and efficient, resulting in fair, objective, and transparent outcomes. The development of a decision support system at CV. Jendral Software has been able to improve the accuracy, efficiency, and effectiveness in the process of selecting the best employees[1] .

Decision Support System (DSS) is a system designed to provide support to managerial decision-makers, especially in semi-structured decision situations[2]. Semi-structured decision situations include conditions where the problem is not fully well-defined, but also not entirely undefined. DSS is designed as an aid for managers to enhance their decision-making capabilities.

The Simple Additive Weighting (SAW) method was chosen as the basis for the DSS method in this study due to its advantages in addressing multi-criteria and assigning weights to each criteria through the summation method. In this method, the criteria values for each alternative will be normalized, and afterward, each normalized value will be multiplied by the predetermined criteria weight. Subsequently, the alternative with the highest value after the normalization process and multiplication by the criteria weight will be selected as the preferred or considered optimal alternative.

Ahmad and Kurniawan [1] developed a system that streamlined the selection process for the best employees at CV. Jenderal Software, achieving a User Acceptance Test preference score of 97.5%, indicating "Very Good" performance. Subsequently, Sitompul, Helmiah, and Rohminatin [2] utilized the Simple Additive Weighting (SAW) method to identify the best employee for reward distribution based on criteria such as attendance, attitude, discipline, responsibility, and task completion, with alternative 6 emerging as the top candidate. Primakara et al. [3] applied the SAW method to recommend the best technology company from 8 alternatives, with MLPT Company receiving the highest preference value of 0.866, indicating the best financial performance for potential investors.

Developing a decision support system using the Simple Additive Weighting (SAW) method, it is expected to provide an effective and efficient solution and help the Shariah Waste Bank of UINSA Surabaya determine the best customers based on predetermined criteria.

II. METHOD

The authors conducted several stages in this research to address the issues encountered at the Shariah Waste Bank of UINSA Surabaya. The following are the stages carried out by the authors:

1. Problem Identification: Conducting interviews with relevant parties at the Shariah Waste Bank of UINSA Surabaya to identify problems or needs.
2. Literature Review: Gathering knowledge and informations on potential solutions to the identified problems.
3. Software Development: This stage followed the Waterfall method to ensure an orderly and practical development process, minimizing errors. It included analyzing needs, designing the system, implementing the design, and testing the software using blackbox testing to ensure it meets the requirements and expectations of the Shariah Waste Bank of UINSA Surabaya.
4. Implementation and Evaluation: Implementing the developed software and evaluating its effectiveness in addressing the identified problems.

The Simple Additive Weight (SAW) method is commonly used in decision support systems to assist in decision-making. This method involves finding the weighted sum of performance ratings for each alternative across all attributes[4].

The SAW method requires normalizing the decision matrix to a scale that is comparable across all available alternative ratings. Additionally, it considers two types of attributes: benefit attributes and cost

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attributes, when selecting criteria for decision making[2]

According to Ahmad and Kurniawan [1], the steps for solving problems using the SAW method are as follows:

1. Determine the criteria to be used as a reference in decision making (C_i).
2. Assign weights to each criteria, ensuring that the total weight equals 1 ($\sum wi = 1$).
3. Create a decision matrix based on the criteria (C_i).
4. Normalize the matrix using an equation adjusted to the type of attribute (benefit or cost attribute), resulting in a normalized matrix R.

$$R_{ij} = \begin{cases} \frac{X_{ij}}{Max\ X_{ij}} & (Benefit) \\ \frac{Min\ X_{ij}}{X_{ij}} & (Cost) \end{cases} \quad (1)$$

Rij is the normalized performance rating of the alternatives Ai for attribute Cj; i = 1,2,3,4 ..., m and j = 1,2,3,4 ..., n.

The preference value (V_i) is given by the equation formula:

$$V_i = \sum_{j=1} W_j R_{ij} \quad (2)$$

These steps outline the process of applying the SAW method to decision making problems, ensuring that all relevant criteria are considered and weighted appropriately to reach an informed decision.

System testing is essential to measure the accuracy of the SAW method used within the system. This testing uses sample data that has been adjusted according to the standard criteria and weights established by the Shariah Waste Bank of UINSA Surabaya.

1. Program Testing: This testing involves inputting sample data into the system that has been integrated with the SAW method. The objective is to verify that the system can process and produce output that aligns with the expected calculations.
2. Manual Testing: This testing is performed by inputting sample data into Microsoft Excel, which has been set up with the SAW method formula. The purpose is to compare the results obtained from the system with those obtained from manual calculations, thereby ensuring that the system provides valid and accurate values.

III. RESULTS AND DISCUSSION

A. ANALYSIS DATA WITH THE SIMPLE ADDITIVE WEIGHTING (SAW) METHOD

The criteria for selecting the best customers to reward are determined based on observations, and interviews. The table below outlines these criteria, including the specific attribute type for each criteria and its corresponding weight.

Table 1 Criteria Data

Criteria (Ci)	Criteria	Type of Atribut	Weight
C1	Number of Transactions	Benefit	0,3
C2	Total Income	Benefit	0,25
C3	Value of Waste	Benefit	0,2
C4	Active Duration	Benefit	0,1
C5	Weight of Waste	Benefit	0,15

The subcriteria for "Number of Transactions" are outlined in the table, These values are crucial for determining the level of customer activity, with higher scores given to those with more transactions.

Table 2 Subcriteria C1

Number of Transactions	
Subcriteria	**Value**
1 - 2 Transactions	0,1
3 - 4 Transactions	0,2
> 4 Transactions	0,3

The subcriteria for "Total Revenue" are outlined in the table below. These values are used to assess the financial gain a customer receives, with higher scores indicating greater income from the waste collected.

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Table 3 Subcriteria C2

Total Income (Rupiah)	
Subcriteria	**Value**
50 - 5.000	0,1
5.001 - 10.000	0,2
10.001 - 15.000	0,3
> 15.000	0,4

The subcriteria for "Value of Waste" are outlined in the table. These values reflect the economic significance of the waste, with higher scores given to waste with greater economic worth.

Table 4 Subcriteria C3

Value of Waste (Rupiah)	
Subcriteria	**Value**
50 - 3.000	0,1
3.001 - 6.000	0,2
6.001 - 9.000	0,3
> 9.000	0,4

The subcriteria for "Active Duration" are outlined in the table. These values are essential for assessing customer loyalty and long term engagement, with higher scores awarded to those with longer active durations.

Table 5 Subcriteria C4

Active Duration (Year)	
Subcriteria	**Value**
1 Year	0,1
1 - 2 Year	0,2
3 - 4 Year	0,3
> 4 Year	0,4

The subcriteria for "Weight of Waste" are outlined in the table. These values are crucial for determining the quantitative contribution of the customer, with higher scores given to those who collect a greater weight of waste.

Table 6 Subcriteria C5

Weight of Waste (Kg)	
Subcriteria	**Value**
0,01 - 5 Kg	0,1
5,01 - 10 Kg	0,2
10,01 - 15 Kg	0,3
15,01 - 20 Kg	0,4
> 20 Kg	0,5

There are 5 samples of customer data used for simulation based on data from the Shariah Waste Bank UINSA Surabaya.

Table 7 Alternative (Ai)

Alternative (Ai)	Name	Criteria				
		C1	C2	C3	C4	C5
A1	Alfin	0,1	0,4	0,4	0,2	0,5
A2	Asrofi	0,1	0,3	0,2	0,2	0,5
A3	Rafly	0,1	0,1	0,2	0,1	0,1
A4	Rehan	0,1	0,2	0,1	0,2	0,2
A5	Huda	0,1	0,1	0,3	0,1	0,1

B. RESULT DISPLAY

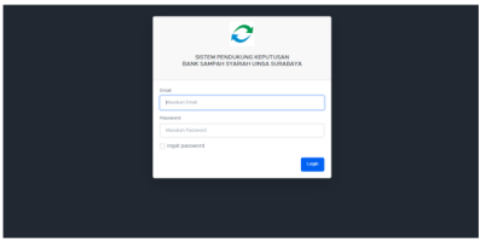

Figure 1. Login Display

The login page displays page for user. Users can input their email and password into the available login form. If the entered data is correct, the user can access the system. If the entered data is incorrect, access to the system is denied.

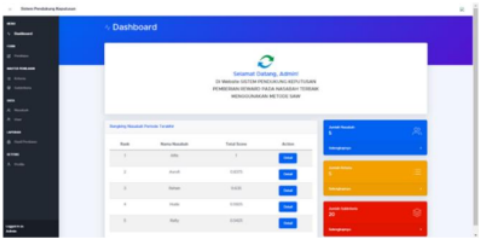

Figure 2. Dashboard Display

The dashboard page displays information for managers and admins. The manager's dashboard shows the number of customers, criteria, subcriteria, and evaluation results, along with customer ranking for the last period. In contrast, the admin's dashboard provides information on customer data, users, and evaluation results, as well as customer ranking for the last period. Both dashboards have a "Details" button to view in-depth customer evaluations.

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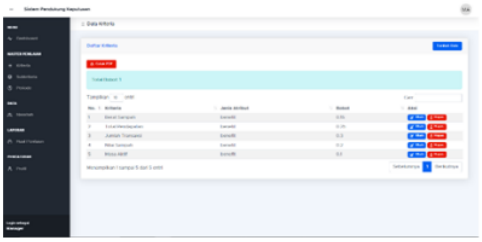

Figure 3. Manages Criteria Data Display

The display shown is the manager's page for managing criteria data. On this page, users can view the total weight of each criteria. There is a search feature to facilitate user data search, as well as an add data feature to input new criteria data. If the manager adds data, they will fill in details such as Criteria, Attribute Type, and Weight. Additionally, there is a "Print PDF" button to save the data in PDF format. The table includes an action column with an "Edit" button to modify data and a "Delete" button to remove data.

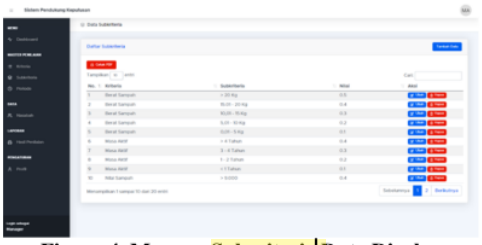

Figure 4. Manage Subcriteria Data Display

The display shown is the manager's page for managing subcriteria data. On this page, users can view the total value of each subcriteria. There is a search feature to facilitate user data search, as well as an add data feature to input new subcriteria data. If the manager adds data, they will fill in details such as Criteria, Subcriteria, and Value. Additionally, there is a "Print PDF" button to save the data in PDF format. The table includes an action column with an "Edit" button to modify data and a "Delete" button to remove data.

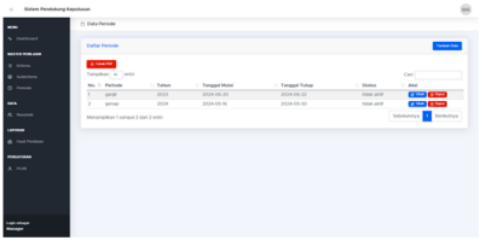

Figure 5. Manages Period Data Display

The display shown is the manager's page for managing evaluation period data. There is a search feature to facilitate data search for the manager, as well as an add data feature to input new period data. If the manager adds data, they will fill in details such as Period, Month, Start Date, End Date, and Status. Additionally, there is a "Print PDF" button to save the data in PDF format. The table includes an action column with an "Edit" button to modify data and a "Delete" button to remove data.

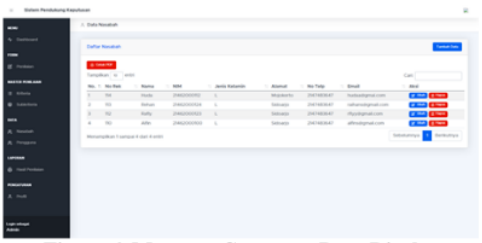

Figure 6. Manages Customer Data Display

The display shown is the admin's page for managing customer data. On this page, users can view the total data of each customer. There is a search feature to facilitate user data search, as well as an add data feature to input new customer data. If the admin adds data, they will fill in details such as customer information and period details. Additionally, there is a "Print PDF" button to save the data in PDF format. The table includes an action column with an "Edit" button to modify data and a "Delete" button to remove data.

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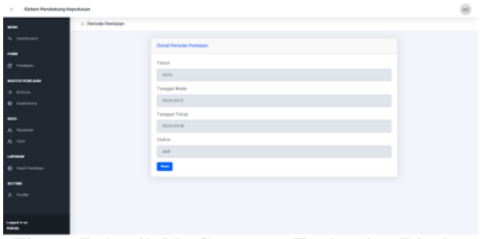

Figure 7. Available Customer Evaluation Display

The display shown is the admin's page for evaluating customers. There is a "Start" button to begin the evaluation of customers for the available period.

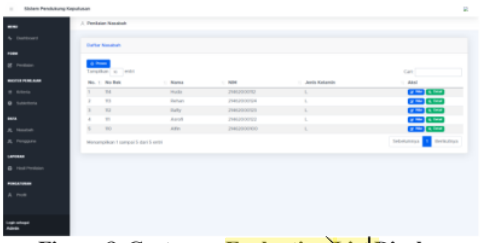

Figure 8. Customer Evaluation List Display

The display shown is the admin's page for selecting customers to be evaluated. It includes a search feature for convenient data retrieval. Pressing the "Evaluate" button will bring up the evaluation form for the selected customer. The "Details" button provides access to the evaluation details previously entered by the admin. Additionally, there is a "Process" button that, upon pressing, triggers the system to calculate evaluation results and rankings using the SAW method.

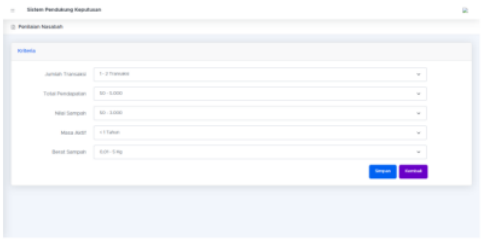

Figure 9. Customer Evaluation Form Display

The display shown is the admin's page for customer evaluations, allowing the admin to input and save customer evaluation data based on several predefined criteria.

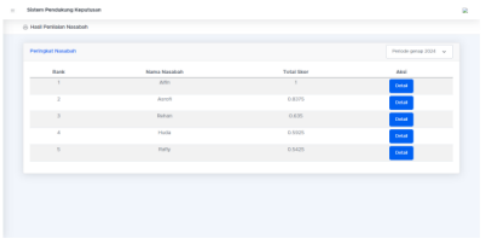

Figure 10. Assessment and Ranking Results Display

The display shown is the user's page for customer rankings, allowing users to view detailed evaluations for each customer based on the selected period.

Figure 11. Customer Assessment Details Display

The display shown is the user's page for assessment and ranking results, offering detailed information about a specific customer's evaluation based on various criteria and subcriteria, including scores and evaluation dates.

C. Result of Black box Testing

A total of 50 test cases using a black box demonstrate that this system meets the defined functional requirements and operates as expected.

D. Results of Testing the Validity of the Simple Additive Weighting (SAW) Method

1. Program Testing: Inputting sample data into the system that has been integrated with the SAW method. Select a customer for evaluation, then the form below will appear. After the admin inputs the values for each alternative, the data is saved into the database.

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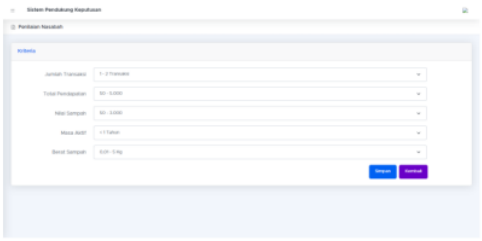

Figure 12. Customer Evaluation Form Display

Then, to calculate the overall evaluation for each alternative using the SAW method, the admin must click the "Process" button. When the user wants to see the results of the calculations and rankings, they can simply select "Evaluation Results" from the report menu. This action will display the ranking and evaluation results, as depicted in the figure 10.

Figure 13. Customer Evaluation Form Display

2. Manual Testing: Inputting sample data into Microsoft Excel, which has been set up with the SAW method formula. The data for each alternative is normalized using the attribute type benefit equation.

1) **Normalization for C1:**

$$R_{11} = \frac{0,1}{Max\ (0,1; 0,1; 0,1; 0,1; 0,1)} = 1$$

$$R_{12} = \frac{0,1}{Max\ (0,1; 0,1; 0,1; 0,1; 0,1)} = 1$$

$$R_{13} = \frac{0,1}{Max\ (0,1; 0,1; 0,1; 0,1; 0,1)} = 1$$

$$R_{14} = \frac{0,1}{Max\ (0,1; 0,1; 0,1; 0,1; 0,1)} = 1$$

$$R_{15} = \frac{0,1}{Max\ (0,1; 0,1; 0,1; 0,1; 0,1)} = 1$$

2) **Normalization for C2:**

$$R_{21} = \frac{0,4}{Max\ (0,4; 0,3; 0,1; 0,2; 0,1)} = 1$$

$$R_{22} = \frac{0,3}{Max\ (0,4; 0,3; 0,1; 0,2; 0,1)} = 0,75$$

$$R_{23} = \frac{0,1}{Max\ (0,4; 0,3; 0,1; 0,2; 0,1)} = 0,25$$

$$R_{24} = \frac{0,2}{Max\ (0,4; 0,3; 0,1; 0,2; 0,1)} = 0,5$$

$$R_{25} = \frac{0,1}{Max\ (0,4; 0,3; 0,1; 0,2; 0,1)} = 0,25$$

3) **Normalization for C3:**

$$R_{31} = \frac{0,4}{Max\ (0,4; 0,2; 0,2; 0,1; 0,3)} = 1$$

$$R_{32} = \frac{0,2}{Max\ (0,4; 0,2; 0,2; 0,1; 0,3)} = 0,5$$

$$R_{33} = \frac{0,2}{Max\ (0,4; 0,2; 0,2; 0,1; 0,3)} = 0,5$$

$$R_{34} = \frac{0,3}{Max\ (0,4; 0,2; 0,2; 0,1; 0,3)} = 0,75$$

$$R_{35} = \frac{0,3}{Max\ (0,4; 0,2; 0,2; 0,1; 0,3)} = 0,75$$

4) **Normalization for C4:**

$$R_{41} = \frac{0,2}{Max\ (0,2; 0,2; 0,1; 0,2; 0,1)} = 1$$

$$R_{42} = \frac{0,2}{Max\ (0,2; 0,2; 0,1; 0,2; 0,1)} = 1$$

$$R_{43} = \frac{0,1}{Max\ (0,2; 0,2; 0,1; 0,2; 0,1)} = 0,5$$

$$R_{44} = \frac{0,2}{Max\ (0,2; 0,2; 0,1; 0,2; 0,1)} = 1$$

$$R_{45} = \frac{0,1}{Max\ (0,2; 0,2; 0,1; 0,2; 0,1)} = 0,5$$

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5) Normalization for C5:

$$R_{51} = \frac{0,5}{Max\ (0,5; 0,5; 0,1; 0,2; 0,1)} = 1$$

$$R_{52} = \frac{0,5}{Max\ (0,5; 0,5; 0,1; 0,2; 0,1)} = 1$$

$$R_{53} = \frac{0,1}{Max\ (0,5; 0,5; 0,1; 0,2; 0,1)} = 0,2$$

$$R_{54} = \frac{0,2}{Max\ (0,5; 0,5; 0,1; 0,2; 0,1)} = 0,4$$

$$R_{55} = \frac{0,1}{Max\ (0,5; 0,5; 0,1; 0,2; 0,1)} = 0,2$$

Table 8 Normalization of Each Alternative for Each Criteria

Alternatif	C1	C2	C3	C4	C5
A1	1	1	1	1	1
A2	1	0,75	0,5	1	1
A3	1	0,25	0,5	0,5	0,2
A4	1	0,5	0,25	1	0,4
A5	1	0,25	0,75	0,5	0,2

The final results of the best customer ranking will determine the recipients of awards:

$$V_{11} = [(0,3 * 1) + (0,25 * 1) + (0,2 * 1) + (0,1 * 1) + (0,15 * 1)] = \mathbf{1}$$

$$V_{21} = [(0,3 * 1) + (0,25 * 0,75) + (0,2 * 0,5) + (0,1 * 1) + (0,15 * 1)] = \mathbf{0,8375}$$

$$V_{31} = [(0,3 * 1) + (0,25 * 0,25) + (0,2 * 0,5) + (0,1 * 0,5) + (0,15 * 0,2)] = \mathbf{0,5425}$$

$$V_{41} = [(0,3 * 1) + (0,25 * 0,5) + (0,2 * 0,25) + (0,1 * 1) + (0,15 * 0,4)] = \mathbf{0,635}$$

$$V_{51} = [(0,3 * 1) + (0,25 * 0,25) + (0,2 * 0,75) + (0,1 * 0,5) + (0,15 * 0,2)] = \mathbf{0,5925}$$

Table 9 Assessment and Ranking Results

Alternative (Ai)	Name	Total Score	Ranking
A1	Alfin	1	1
A2	Asrofi	0,8375	2
A3	Rafly	0,5425	5
A4	Rehan	0,635	3
A5	Huda	0,5925	4

Based on 5 samples of customer data used for a simulation based on data from the Shariah Waste Bank UINSA Surabaya, it was determined that A1 (Alfin) was the most deserving award recipient with a score of 1. The second recommendation was A2 (Asrofi), who received a score of 0.8375.

IV. CONCLUSION

Based on the research findings, a decision support system has been successfully designed and developed to reward the best customers of the Shariah Waste Bank. Utilizing the Simple Additive Weighting (SAW) method, the system objectively ranks customers by normalizing and weighting criteria such as Number of Transactions, Total Income, Value of Waste, Active Duration, and Weight of Waste. This approach ensures fairness and transparency in evaluating customer contributions. Black box testing with 50 test cases confirmed that the system met all functional requirements and operated reliably in real-world scenarios. Program and manual testing further validated the SAW method, consistently identifying A1 (Alfin) as the highest-ranked customer with a score of 1, followed by A2 (Asrofi) with a score of 0.8375, aligning with expectations. The implementation of the SAW method in this decision support system has proven beneficial, providing an objective basis for rewarding customers, promoting transparency, and enhancing decision-making efficiency.

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