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Decision support system for selecting delivery service partners at the Kefmenanu branch using the multi attribute utility theory (MAUT)

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Abstract

Shipping is the process of transporting goods from producers to consumers. Most goods will be shipped through a cargo transportation network (physical goods) delivered by land, sea and air. The increasing number of internet users among the public encourages more people to ship goods online. The many choices of shipping services available often cause confusion and obstacles for the public in determining the best service according to their needs, both in terms of cost, delivery time, type of payment and shipping costs. To avoid existing problems, a decision support system is needed that can make it easier for the public to make the right decision in choosing a shipping service partner. The Decision Support System (DSS) for selecting a shipping service partner at the Kefamenanu branch aims to help the public make more precise and efficient decisions in choosing a shipping partner. The method used in this study is the Multi Attribute Utility Theory (MAUT), which allows comparison of various important criteria in selecting a delivery partner. The decision-making process is carried out by assessing each alternative delivery partner based on the weight of the previously determined criteria. Each partner is then given a score for each criterion, which is then calculated using the maut method to produce a final score with the highest score from each alternative. The results of this system are able to provide the best recommendations in selecting delivery services objectively. That way, the Kefamenanu community can make wiser decisions. The implementation of this SPK can improve operational efficiency and community satisfaction, as well as reduce errors in decision making. Thus, this system can help the community to improve the performance of goods delivery at the Kefamenanu branch.

Keywords: *Delivery of Goods, Decision Support System (DSS), Kefamenanu Community, Maut, Performance*

1. INTRODUCTION

The advancement of technology is currently highly essential for society, as it aids and simplifies daily activities. This includes the use of computers and other electronic devices such as smartphones, televisions, radios, and more. In particular, many businesses now operate online, enabling broader market reach and increasing the need for shipping services to deliver goods beyond the island of East Nusa Tenggara (NTT) [1]. Examples of items being shipped include food, beverages, fruit gift baskets, and various other goods. Shipments are carried out using various modes of transportation land, air, and sea allowing people to send goods without having to deliver them personally, thus relying heavily on shipping services [2].

Several shipping service partners operate in the city of Kefamenanu, including JNT Express Kefamenanu, JNE Kefamenanu, Lion Parcel Kefamenanu, SAP Express Kefamenanu, Gerai Sicepat Express Kefamenanu, Tiki Kefamenanu, the Kefamenanu Post Office, and Ninja Express

Kefamenan [3]. Many residents choose to use these service providers due to the relatively convenient process of sending packages, which only requires dropping off items for delivery to their destination [4]. These services are further enhanced by the availability of internet access and social media platforms. However, people often still struggle to choose the most suitable shipping partner due to various criteria [5]. Therefore, it is important for the public to be more selective in choosing a shipping service partner to avoid potential issues. To address this, a decision support system is needed to assist people in making informed decisions [6].

A Decision Support System (DSS) is a component of computer-based information systems designed to aid in making accurate decisions [7]. To develop a DSS, a specific approach or model is required. This study uses the Multi-Attribute Utility Theory (MAUT) method [8]. The MAUT method is a decision-making approach that involves calculating the weighted scores of various attributes to produce a final value, where the highest score indicates the best option [9]. The purpose of developing this decision support system is to better understand the shipping process in Kefamenanu. Many people remain uncertain about choosing the best shipping service partner, particularly based on the characteristics of the goods, such as fragility, delicacy, large dimensions, and so on. Therefore, a system is needed to assist the public in making the right decision [10].

2. LITERATURE REVIEW

The MAUT (Multi-Attribute Utility Theory) method is a scheme in which the total evaluation $V(x)$ of each alternative is defined as the weighted sum of the relevant values for each attribute dimension. MAUT is used to convert multiple criteria into numerical values on a scale from 0 to 1, where 0 represents the worst option and 1 represents the best [11]. This method allows for quantitative comparisons by combining the measurement of various costs, risks, and benefits. MAUT serves as a decision support method in situations where multiple criteria must be considered when making important decisions [12].

MAUT can provide the best possible decision for the public in selecting the most suitable shipping service based on their needs. One of the advantages of the MAUT method is its ability to quickly determine the final outcome and offer the best alternative with optimal results [13][9][14][15].

The following is the formula 1 used in the MAUT method:

$$w_i = \frac{w_1'}{\sum w_1'} \qquad (1)$$

Where:

w_i = The relative weight of the *i*-th criterion
$\sum w_1'$ = The total importance level of the weights for all criteria
w_1' = The importance level of the weight for each individual criterion

The utility functions used to normalize each alternative—aimed at obtaining the evaluation result of alternative *x*—are expressed on a scale from 0 to 1. This is referred to as U *(x)*, and can be seen in the following formula 2 and formula 3:

$$u(x) = \frac{x - x_1^-}{x_1^+ - x_1^-} \qquad (2)$$

Where:

$U(x)$ = Utility value of alternative *x*
x_1^- = The worst value of the *i*-th criterion among all alternatives
x_1^+ = The best value of the *i*-th criterion among all alternatives

$$V(x) = \sum_{i=1}^{n} wi * vi(x) \qquad (3)$$

Where:

V *(x)* = Total evaluation of alternative *x*
Wi = Relative weight of the *i*-th criterion
Vi = Evaluation result of the *i*-th criterion for alternative *x*

i = Index of the criterion

3. RESEARCH METHOD

3.1 Type of Research

This study aims to design and develop a system that assists the public in selecting a shipping service partner. The type of research used in this study is applied research. To support the system design, data were collected by directly surveying 100 respondents who are users of shipping services. The data obtained were used to analyze user preferences and needs in choosing the most suitable shipping partner [14].

3.2 Research Stages

In this research, the author applies the Multi-Attribute Utility Theory (MAUT) method. The stages of the research process are illustrated in the figure 1 below [15].

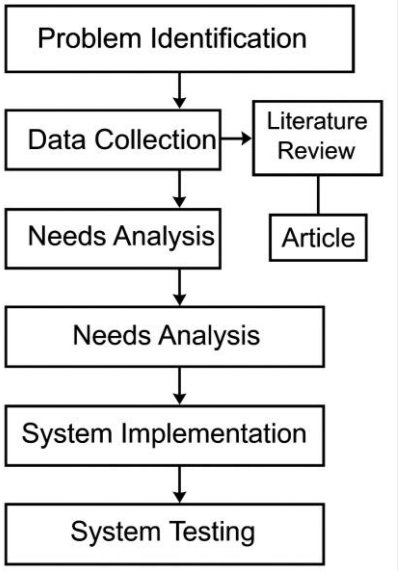

Figure 1. Research Stages

1. Problem Identification

The first stage begins with identifying the problem to understand the challenges faced by the public in selecting a shipping service provider. Through problem identification, the researcher can focus on solving the specific issues encountered by the community.

2. Data Collection

In this stage, the researcher collects data through interviews with shipping service partners in Kefamenanu, including JNT Express Kefamenanu, JNE Kefamenanu, Lion Parcel Kefamenanu, SAP Express Kefamenanu, Gerai Sicepat Express Kefamenanu, Tiki Kefamenanu, the Kefamenanu Post Office, and Ninja Express Kefamenanu. The data collected includes service coverage, delivery time, payment methods, and shipping costs.

3. System Requirements Analysis

After identifying the core problems, a system requirements analysis is conducted to address and solve the issues. This includes both functional and non-functional requirements analysis. Functional and non-functional testing is performed on the developed software to verify whether it operates in accordance with the design specifications.

4. System Design

At this stage, the system is designed using the Waterfall Method. The Waterfall model is a classic, systematic, and sequential approach to software development.

5. System Implementation

System implementation is the process of deploying the designed system so it is ready for use. This includes installation, testing, and utilization of the new or upgraded system. Implementation involves multiple phases, starting from planning and preparation to system rollout and monitoring.

6. System Testing

System testing is the process of evaluating the complete and integrated software system to ensure it functions according to user needs and predefined specifications. This phase follows unit and integration testing, and precedes user acceptance testing.

3.3 System Design

In the system design phase, the researcher develops the system using the Waterfall Method. The Waterfall method is a classical software development model characterized by a systematic, sequential approach to building software [16][17].

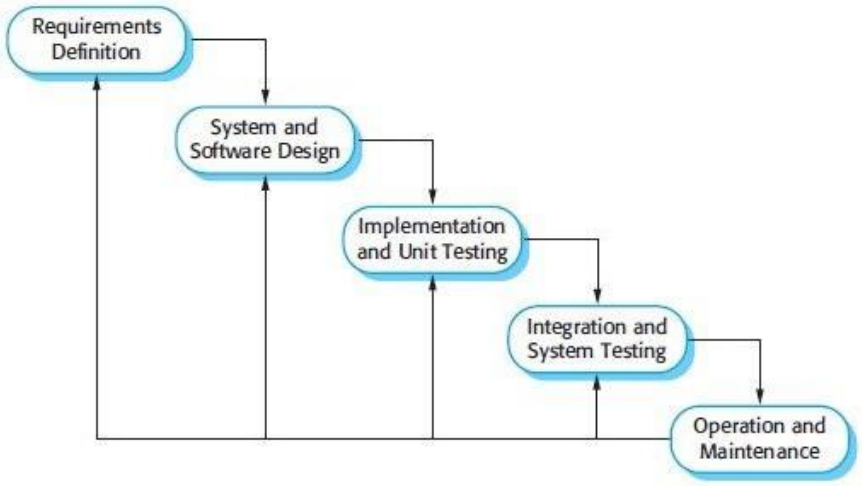

Figure 2. Waterfall Method

Each stage in the Waterfall Method, as shown in Figure 2 above, is described in detail as follows:

1. Requirements Analysis

This stage involves the identification and deep understanding of the system users and stakeholders. The main goal is to gather both functional and non-functional data about the shipping service partners, which will serve as the foundation for software development.

2. Design

At this stage, the collected data is transformed into a specific software design. The design includes the system architecture, user interface design, and software module design. The purpose is to create a clear guideline for shipping partners in implementing the software.

3. Development

This stage involves the actual coding or implementation of the software based on the previously defined design. The coding is done using the PHP programming language and MySQL as the database.

4. Testing

After implementation, the software is tested to ensure that it aligns with the design. The objective is to detect and fix any errors before the software is released to users.

5. Maintenance

This final stage occurs after the software has been deployed and is in use. It includes routine maintenance, updates, and necessary fixes to ensure the software continues to perform as intended.

3.4 Tools and Materials

a. Research Tools

Several tools used in this research consist of hardware and software:

*Hardware:*Acer Laptop, 4 GB RAM, Printer

Software: Google Chrome, Windows Operating System, PHP Programming Language, UML

b. Research Materials

The materials used in this research include data collected from each shipping service provider in Kefamenanu, as well as data obtained from the people of Kefamenanu.

4. RESULTS AND DISCUSSION

4.1. System Modeling

The modeling approach used in the development of the shipping service partner selection system is UML (Unified Modeling Language) a standard modeling language used to design and visualize software systems. In this research, two types of UML diagrams are used: the Use Case Diagram and the Activity Diagram.

a). The Use Case Diagram is used to depict the interaction between the system and its users (actors), and to identify the main functionalities provided by the system.

b). The Activity Diagram is used to model the workflow or processes within the system, starting from the partner selection to the confirmation of the delivery service.

The use of these two diagrams helps the researcher understand and design the system's workflow more systematically and structurally before implementation begins.

4.2. Use Case Diagram

Figure 3, The Use Case Diagram illustrates the interactions between the actors (system users) and the system itself. The main actors in the system are the admin and the user/community. The admin is responsible for inputting data related to the shipping partners, such as alternative data, criteria data, sub-criteria, evaluations, calculations, and results.

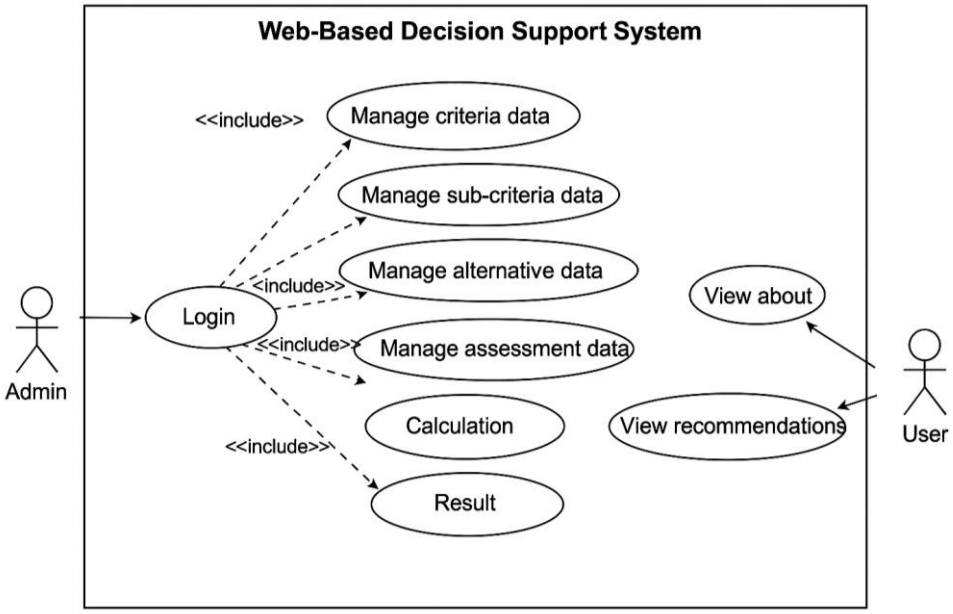

Figure 3. Use Case Diagram for DSS in Shipping Partner Selection

4.3. Implementation of the MAUT Method

The MAUT method is applied by calculating the utility value of each shipping service partner based on pre-weighted criteria. This process is conducted to determine the partner with the highest final score that best meets user needs. The following are the steps in applying the MAUT method for selecting shipping partners in Kefamenanu.

Table 1. Shipping Service Partners

Alternative	Symbol
J&T Express	A1
JNE Express	A2
Lion Parcel	A3
SAP Express	A4
SiCepat Outlet	A5
TIKI	A6
Post Office	A7
Ninja Express	A8

The explanation of Table 1 above includes a brief description of each shipping service partner:

1. J&T Express
   A delivery company well-known for its reliable tracking services and broad coverage across Indonesia. J&T also offers a service called *J&T Super*, which guarantees parcel delivery in under 12 hours.
2. JNE Express
   An established courier company since 1990 with an extensive distribution network throughout Indonesia. JNE is recognized for its *Super Speed (SS)* service, ensuring rapid delivery.
3. Lion Parcel
   Lion Parcel is a logistics service that handles the shipment of goods, documents, and packages. Leveraging the Lion Group's fleet, it offers quick delivery options including priority and international shipments, as well as large and jumbo package services.
4. SAP Express
   Also known as SAPX, this logistics company specializes in intercity deliveries for packages and documents. Their services include COD (Cash On Delivery) and fulfillment logistics, with a delivery network that covers more than 7,200 sub-districts in Indonesia.
5. SiCepat Outlet
   SiCepat offers courier services that include COD and regular delivery. They have numerous outlets across various locations, enabling customers to pick up packages from the nearest outlet. SiCepat also provides a "Picked up by" service, where a courier collects the package from the designated address.
6. TIKI
   A long-standing courier company offering services such as *Super Speed (SS)* for guaranteed fast delivery.
7. Post Office (Kantor Pos)
   A government-owned postal service provider offering various services, including *Pos Next Day* and *Pos Sameday* delivery options.
8. Ninja Express
   A technology-driven courier company with a broad network, offering *Ninja Same Day Delivery*, which guarantees same-day delivery for packages.

Table 2. Criteria Data

Symbol	Criteria	Weight	Sub-Criteria	Scale
C1	Coverage Type	30	Domestic	1
			International	2
C2	Delivery Time	25	1 week	1
			5 days	2
			3–4 days	3
			1 day	4
C3	Payment Method	20	Cash	1
			COD	2
C4	Shipping Cost	25	> Rp 60,000	1
			Rp 41,000 – Rp 60,000	2
			Rp 31,000 – Rp 40,000	3
			Rp 20,000 – Rp 30,000	4
			< Rp 20,000	5
Total		100		

This table 2, presents the criteria used to evaluate each shipping service partner. The criteria are weighted to represent their importance in the decision-making process.

C1: Range of Service (Domestic or International)
C2: Delivery Time (From 1 day to 1 week)
C3: Payment Method (Cash or COD)
C4: Shipping Cost (Ranging from over Rp. 60,000 to less than Rp. 20,000)

Table 3. Alternative Data Based on Criteria

Alternative	C1	C2	C3	C4
J&T Express	International	1 day	COD	< Rp 20,000
JNE Express	International	1 day	COD	Rp 31,000 – Rp 40,000
Lion Parcel	International	5 days	COD	Rp 31,000 – Rp 40,000
SAP Express	Domestic	5 days	Cash	Rp 31,000 – Rp 40,000
SiCepat Outlet	International	3–4 days	Cash	Rp 31,000 – Rp 40,000
TIKI	International	5 days	COD	Rp 20,000 – Rp 30,000
Post Office	International	3–4 days	COD	< Rp 20,000
Ninja Express	International	3–4 days	Cash	Rp 20,000 – Rp 30,000

This table 3, shows the actual data for each shipping partner, providing the values of each partner's service according to the defined criteria (C1 to C4). Each alternative is evaluated based on the type of service, delivery time, payment method, and shipping cost.

Table 4. Normalized Weights

C1	C2	C3	C4	Total
0.30	0.25	0.20	0.25	1.00

This table 4, shows the normalized weights of the criteria, ensuring that each factor contributes proportionally to the decision-making process. Each criterion is assigned a weight, and the total weight sums to 1.

Table 5. Alternatives Based on Scale Values

Alternative	C1	C2	C3	C4
J&T Express	2	4	2	5
JNE Express	2	4	2	3
Lion Parcel	2	2	2	3
SAP Express	1	2	1	3
SiCepat Outlet	2	3	1	3
TIKI	2	2	2	4
Post Office	2	3	2	5
Ninja Express	2	3	1	4
Xi -	1	2	1	3
Xi +	2	4	2	5

This table 5, shows how each shipping service is rated based on a scale of 1 to 5 for each criterion. This scale helps to evaluate the performance of each service in terms of range, delivery time, payment methods, and shipping cost.

Table 6. Utility Values

Alternative	C1	C2	C3	C4	Total
J&T Express	0.30	0.25	0.20	0.25	1.000
JNE Express	0.30	0.25	0.20	0.00	0.750
Lion Parcel	0.30	0.00	0.20	0.00	0.500
SAP Express	0.00	0.00	0.00	0.00	0.000
SiCepat Outlet	0.30	0.125	0.00	0.00	0.425
TIKI	0.30	0.00	0.20	0.125	0.625
Post Office	0.30	0.125	0.20	0.25	0.875
Ninja Express	0.30	0.125	0.00	0.125	0.550

This table 6, calculates the utility value of each shipping service based on their ratings for each criterion. The utility values are computed by multiplying the normalized weight of each criterion by the scale value, resulting in a total utility score for each service.

Table 7. Ranking

Alternative	Score	Rank
J&T Express	1.000	1
Post Office	0.875	2
JNE Express	0.750	3
TIKI	0.625	4
Ninja Express	0.550	5
SiCepat Outlet	0.425	6
Lion Parcel	0.500	7
SAP Express	0.000	8

This table 7, shows the final rankings of the shipping services based on their utility scores. The ranking is in descending order, with the highest-ranked service being the most suitable option for the user based on the weighted criteria.

a). J&T Express: Ranked 1st with the highest utility score.
b). Kantor Pos: Ranked 2nd, following closely behind.
c). JNE Express: Ranked 3rd.
d). Tiki: Ranked 4th.
e). Ninja Express: Ranked 5th.
f). Gerai Si Cepat: Ranked 6th.
g). Lion Parcel: Ranked 7th.
h). Sap Express: Ranked 8th with the lowest utility score.

4.4. System Implementation

The implementation process of the shipping partner selection system begins when the user opens the provided website link via a browser. Once accessed, the system automatically redirects the user to the homepage. This homepage functions as the main interface that grants access to various system features, such as the *About* page, the *Recommendation* menu, and the *Admin Login* menu. Figure 4, displays the homepage layout:

Figure 4. Main Page Display

Illustrates the main page of the shipping partner selection system. The “About” page in the system is designed to provide information about the available shipping partners in Kefamenanu. This page aims to allow users to gather information about each shipping partner. On this page, users are presented with a list of shipping partners, such as J&T Express, JNE, TIKI, SiCepat, and others operating in the Kefamenanu area. Figure 5, shows the display of the “About” page.

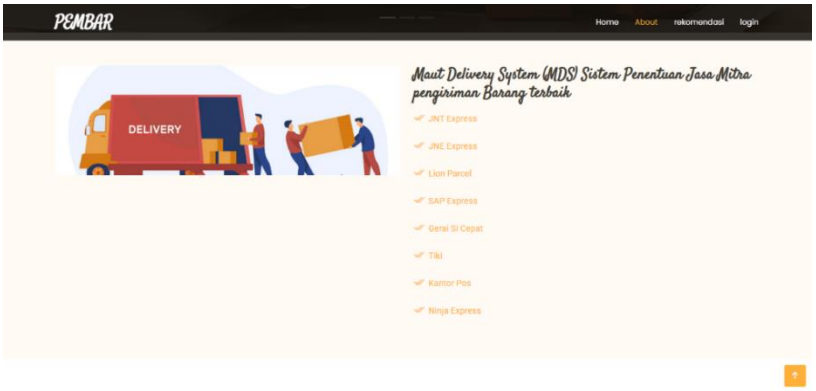

Figure 5. About Page Display

Shows the "About" page of the system. To view more detailed information about a particular shipping partner, the user simply clicks on the name of the partner listed, such as JNT Express, JNE Express, or others. Once the partner's name is clicked, the system will automatically direct the user to the specific information page for that partner. On this page, users can find detailed information about the selected shipping partner. The display of the detailed "About" page is shown in Figure 6.

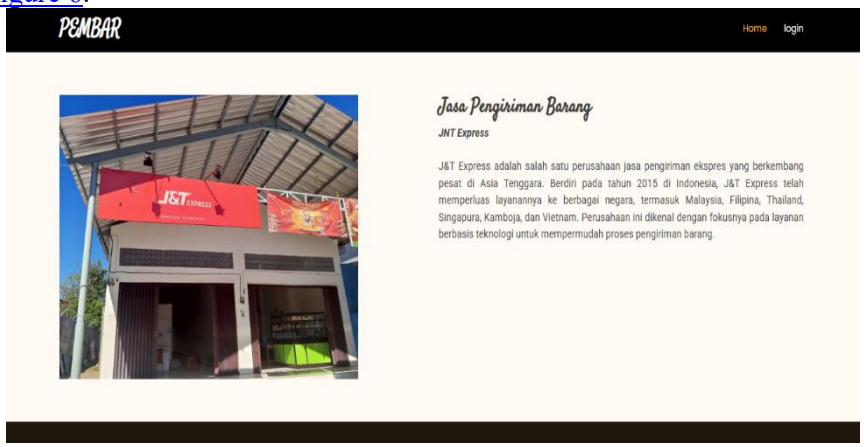

Figure 6. Detailed About Page Display

This menu displays the shipping partner recommendations based on calculations made by the admin using the MAUT method. In this menu, users can see a list of shipping partners along with the percentage results of the calculations, which represent the quality or compatibility of each partner with the criteria that have been set. The recommendation results are presented in an informative form, in a card layout, with each partner being given a percentage value that reflects their alignment with the user's needs. Figure 7, shows the display of the shipping partner recommendation page.

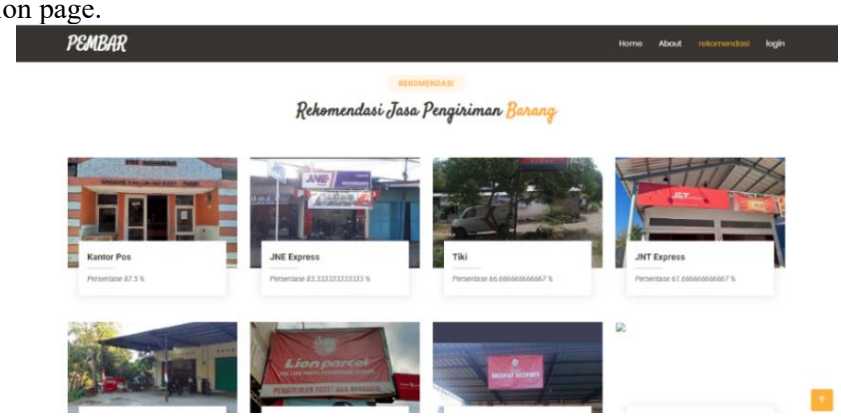

Figure 7. Recommendation Page Display

If the user clicks on one of the shipping partner images in the recommendation menu or any other page, the system will automatically redirect the user to the partner's detail page. On the detail page, users can find information such as the service coverage (domestic or international),

payment type (cash on delivery (COD) or bank transfer), shipping time, and shipping costs. Additionally, this page also provides a feature to check shipping fees based on the weight of the goods being shipped. Users simply need to enter the weight of the goods (e.g., in kilograms or grams) into the available field and select the destination (by province, city, district, and village). The system will then calculate and display the shipping cost based on the entered data. Figure 8, shows the display of the shipping partner detail recommendation page.

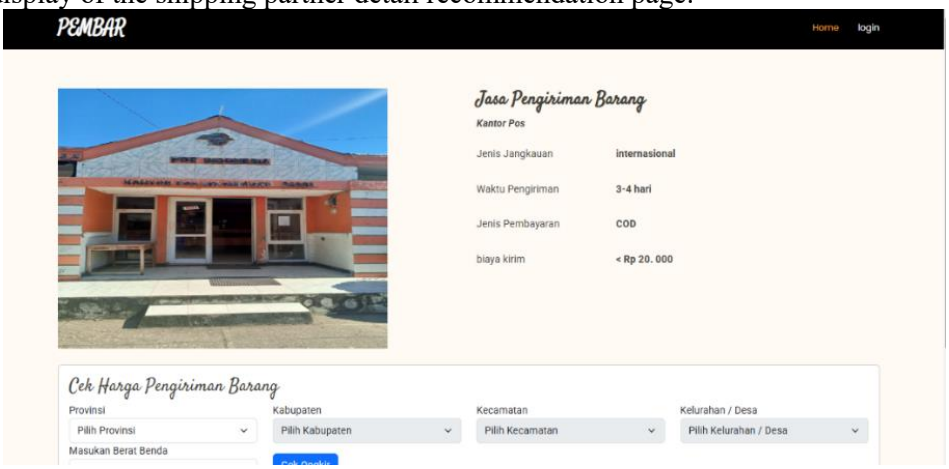

Figure 8. Shipping Partner Recommendation Detail Page Display

The login menu in this system is specifically for use by the admin to access the data management and calculation features within the system. When the admin clicks on the login menu, they will be directed to the login form page, which consists of fields for the username and password. The admin must enter valid credentials to access the system. If the login attempt fails due to incorrect username or password, the system will display an error message and provide an option to attempt login again. However, if the admin successfully logs in, the system will redirect to the admin dashboard page. The login page display can be seen in Figure 9.

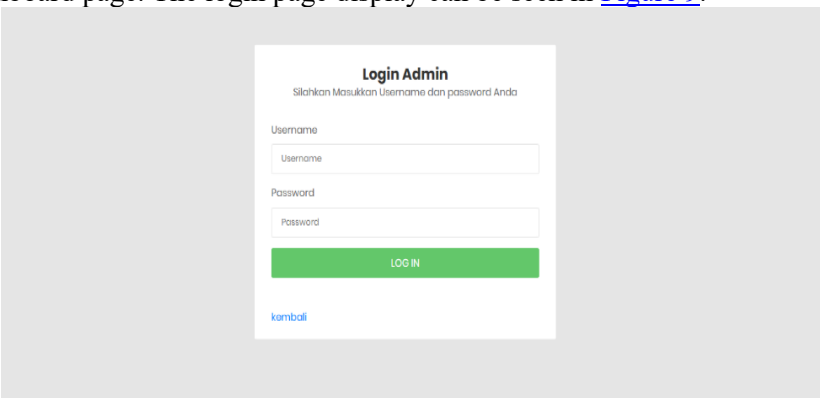

Figure 9. Login Page Display

After successfully logging in, the admin is granted full access to the main system features displayed on the dashboard page. These features include entering or updating criteria, sub-criteria, and alternatives, performing alternative assessments for each criterion, conducting recommendation calculations using the MAUT method, and managing the recommendation results that will be displayed to users. The admin dashboard page is shown in Figure 10.

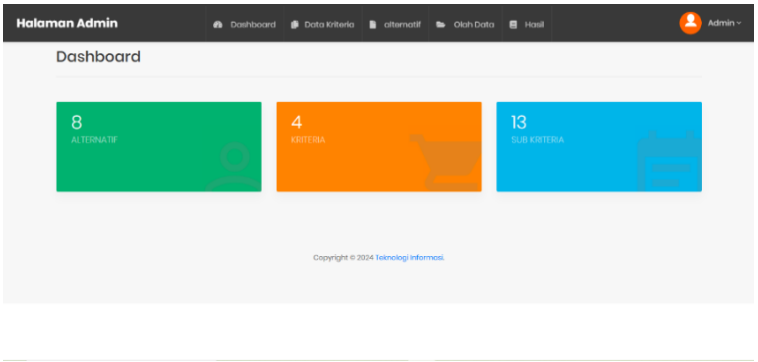

Figure 10. Admin Dashboard Page Display

The *Alternatives* menu is one of the features in the system that displays data on shipping partners in Kefamenanu and also facilitates the management of partner data. In the *Alternatives* menu, the admin can add new partner data by filling out a form containing relevant information about the partner through the "Add Data" button. Additionally, the "Edit" button allows the admin to update existing data, such as correcting images or changing information. The "Delete" button enables the removal of partner data that is no longer active or relevant. Meanwhile, the "Search" button helps the admin quickly find a specific partner using keywords, making data management faster and more efficient. Figure 11, shows the *Alternatives* data page display.

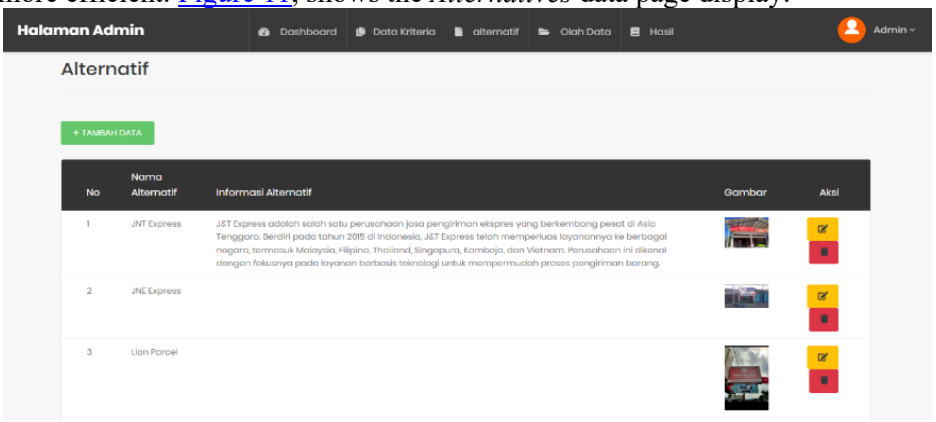

Figure 11. Alternative Data Page Display

The *Criteria* menu is another feature in the system designed to display the evaluation criteria data used in selecting shipping partners in Kefamenanu, as well as facilitate the management of criteria data. In this menu, there is an *Add* button to add new criteria by filling out the relevant form, an *Edit* button to update existing criteria data, and a *Delete* button to remove criteria data that is no longer relevant. Additionally, there is a *Search* button that helps the admin quickly find specific criteria using keywords, making data management faster and more efficient. Figure 12 shows the *Criteria* data page display.

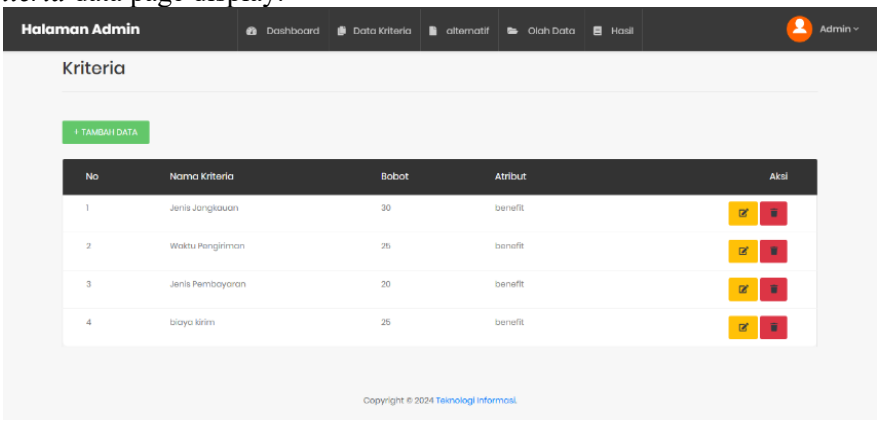

Figure 12. Data Criteria Page Display

The *Subcriteria* menu is a feature in the system used to manage the subcriteria data for evaluating shipping partners in Kefamenanu. This feature provides an *Add* button to insert new subcriteria, an *Edit* button to make changes to existing subcriteria, and a *Delete* button to remove subcriteria that are no longer needed. Additionally, there is a *Search* feature that helps the admin easily find specific subcriteria using keywords, making the data management process more efficient and organized. The display of the *Subcriteria* data page is shown in Figure 13.

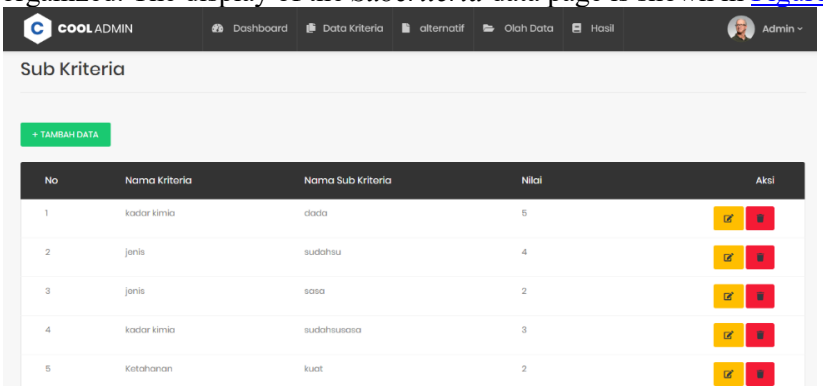

Figure 13. Data Subcriteria Page Display

The *Evaluation* menu is a feature that displays the evaluation data of alternatives and allows for rating the alternatives based on the predetermined criteria. This menu provides buttons to add or modify evaluations simultaneously. This feature enables the admin to easily add new subcriteria or edit existing ones through a single multifunctional button. The *Evaluation* menu is shown in Figure 14.

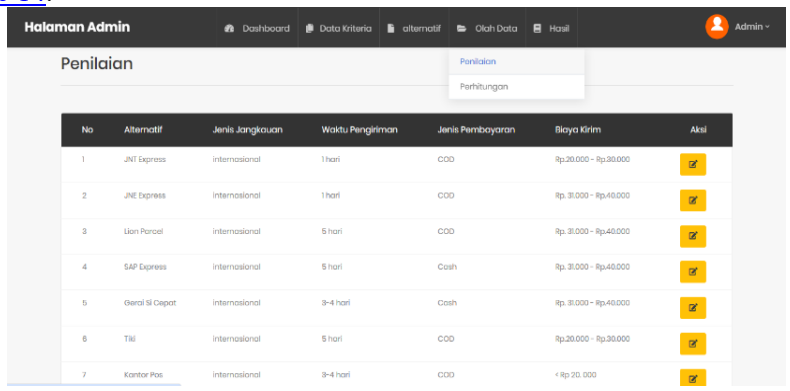

Figure 14. Data Evaluation Page Display

The *Calculation* menu is a feature that shows the process of selecting a delivery partner using the Multi-Attribute Utility Theory (MAUT) method. Generally, this menu provides a complete overview of how the system evaluates various delivery partners based on the criteria and subcriteria that have been set. In this menu, the admin can view the calculation steps used to determine the best delivery partner. Figure 15, shows the display of the *Calculation* menu page.

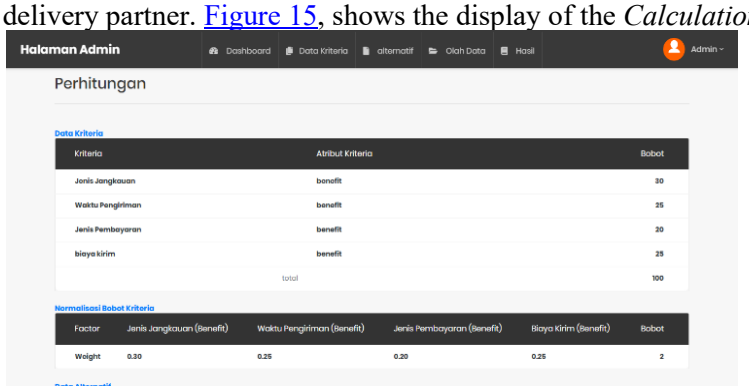

Figure 15. Calculation Menu Page Display

The *Results* menu is a feature that displays the final outcome of the delivery partner selection process using the Multi-Attribute Utility Theory (MAUT) method. This menu focuses solely on

presenting the calculation results and rankings of delivery partners based on the final scores obtained from the evaluation of criteria and subcriteria. The admin can view the ranking of the best delivery partners based on the previously calculated scores, making it easier to select the most suitable partner for the needs. Figure 16, below shows the display of the *Results* data page.

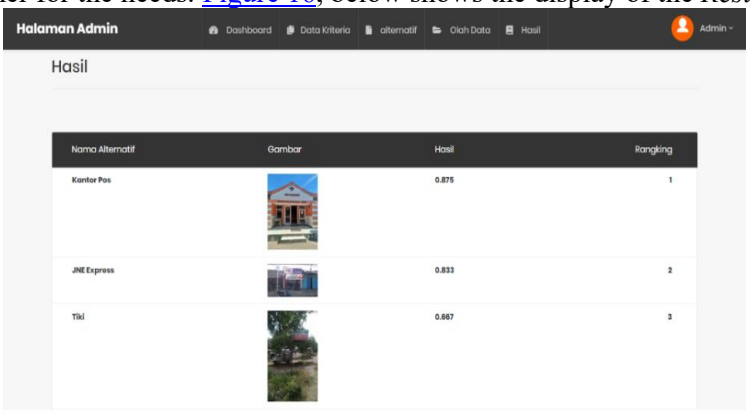

Figure 16. Display of Results Data Page

5. CONCLUSION

Based on the development and discussion results, it can be concluded that the implementation of a Decision Support System (DSS) based on a website can provide significant contributions in helping the public select the delivery service that best suits their needs. This system allows users to compare various delivery partners based on several important criteria such as shipping costs, estimated delivery time, payment methods, and service area coverage. With a user-friendly system design and the use of PHP and MySQL-based technology, this system can efficiently manage data and provide accurate and informative recommendations. This simplifies the decision-making process, making it faster and more objective. Overall, this DSS provides a practical and innovative solution for the public in facing the various available delivery services in Kefamenanu. Further developments, such as integration with real-time systems and the development of a mobile version, can further enhance the benefits and utility of this system in the future.

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