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Decision Support System for Selecting the Best Bus Destination for Toraja using the Weighted Product Method

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Abstract

This research aims to develop a Decision Support System (DSS) that can assist in selecting the best bus for tourism purposes in Toraja. The objective of this research is to facilitate the decision-making process for prospective tourists who want to use buses as their means of transportation during their visit to Toraja. The method employed in this research is the Weighted Product (WP) method. This method was chosen due to its ability to handle multiple criteria, enabling selection based on various relevant factors such as price, service quality, bus capacity, operational schedule, and level of comfort. Furthermore, the collected data will be input into the developed DSS using the WP method. The DSS will calculate relative scores for each bus based on the predetermined criteria weights. The results of this research are expected to provide objective and accurate recommendations for selecting the best bus. These recommendations can serve as a guide for prospective tourists in choosing a bus that suits their needs and preferences. Additionally, this research can also provide valuable insights for bus operators in improving service quality and customer satisfaction.

Keywords: Queuing Applications; Client Server; SDLC Prototype Model; Decision Support System.

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Introduction

Tourism is one of the sectors with great potential in Indonesia's economy (Simanjuntak et al., 2023). One of the captivating tourist destinations, both for local and international travellers, is Toraja (Darmawan et al., 2019). Toraja is renowned for its natural beauty, rich culture, and unique and fascinating tourist attractions (Halid et al., 2022). As a popular destination, Toraja is frequently visited by tourists seeking a unique and enchanting experience. Buses are a commonly used means of transportation for various activities, such as tourism and travel (Rahadi et al., 2022). During a trip to Toraja, choosing the right mode of transportation, especially the right bus, is crucial. Opting for the right bus can provide a comfortable, safe, and efficient travel experience for tourists. However, selecting the best bus can be a complex and time-consuming process due to several factors that need to be considered, such as schedules, routes, prices, comfort, and reliability (Alamatsaz et al., 2022).

Currently, there are many online travel applications offering bus options for travelling to Toraja. However, it is not uncommon for passengers to feel unsatisfied with their choices. Additionally, foreign tourists often face confusion when selecting a bus due to a lack of information available to them (Witlox et al., 2022). Furthermore, based on the researcher's experiences of frequently using buses as a mode of transportation from Makassar to Toraja, several challenges are often encountered, including lost belongings, uncomfortable seats, incomplete facilities, and drivers' unfamiliarity with passenger comfort. Although there are many online travel applications providing bus information, none have been specifically developed to assist tourists in selecting the best bus for Toraja. Therefore, this research aims to fill this gap by developing a Decision Support System specifically designed for choosing the best bus to Toraja. With this system, it is expected that tourists will benefit from selecting a bus that suits their needs. Additionally, the development of this system will contribute to the improvement of the tourism sector in Toraja by enhancing transportation service quality. Based on the aforementioned background, the title "Decision Support System for Selecting the Best Bus to Toraja Using the Weighted Product Method" is proposed as a solution to the current issues.

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Literature Review

Definition of a decision support system

A Decision Support System (DSS) is a system designed to assist in complex and strategic decision-making within an organization or specific context (Phillips-Wren et al., 2021; Witlox et al., 2022). DSS combines different data, models, and analysis tools to provide relevant and useful information to users for decision-making purposes. The primary objective of a DSS is to provide support in addressing complex, ambiguous, and structured problems that involve multiple factors and diverse consequences. DSS helps reduce uncertainty and complexity by providing relevant information, analyzing data, and modelling different scenarios.

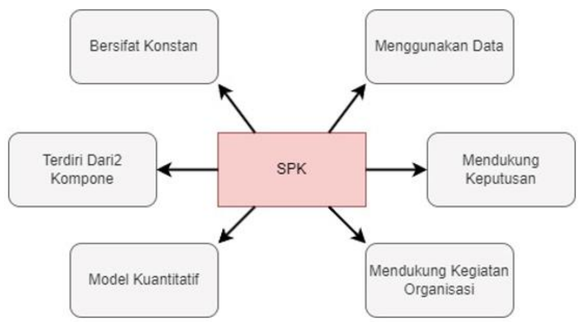

Figure 1. Characteristics of a Decision Support System

Weighted Product Method

The Weighted Product (WP) method is one of the techniques used in multi-criteria decision-making. This method is commonly employed to select the best alternative based on predetermined criteria. The Weighted Product method utilizes a mathematical operation called multiplication to connect attribute ratings. Each attribute is assessed with its corresponding attribute weight, and this process is similar to normalization. The weights of each criterion are multiplied by the alternative ratings for that criterion, and the resulting products are then summed up for each alternative. The Weighted Product method can aid in the decision-making process; however, calculations using the WP method only yield the highest value or the highest score, thus selecting the alternative with the highest value as the best alternative.

The steps involved in the Weighted Product method are as follows:

1. The first step is to determine the candidate alternatives (A) to be chosen.
2. Next, identify the criteria (C) that will serve as a reference for decision-making, along with their respective attributes of being either a cost or a benefit.
3. Determine the suitability ratings for each alternative on each criterion and create the decision matrix.

Normalize the weights using the following formula:

$$wj = wj / \Sigma wj \quad (1)$$

Calculate the Value Vector S using the formula:

$$S_i = \prod_{j=1}^{n} x_{ij}^{w_j} \quad (2)$$

Calculate the Value Vector V using the formula:

$$V_i = \frac{\prod_{j=1}^{n} x_{ij}^{w_j}}{\prod_{j=1}^{n} (x_j)^{w_j}} \text{ atau} V_1 = \frac{S1}{S1+S2+S3+S4+S5+S6+S7+S8} \quad (3)$$

Method

Research Phases

The following are the stages carried out by the author in developing a decision support system for selecting the best bus to Toraja using the Weighted Product method:

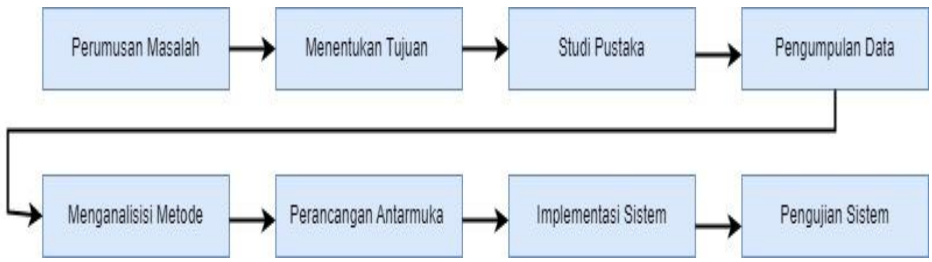

Figure 2. Stages of Research.

The desired outcome. In this research, the author follows a design arrangement to determine the best bus to Toraja by conducting several stages. The following stages are the necessary steps to be taken in conducting research on the best bus to Toraja.

System Design Methodology

In this system, the procedures are depicted using UML (Unified Modeling Language). UML is utilized to create a use-case diagram, followed by describing each process in an activity diagram. The actors involved in the system are as follows:

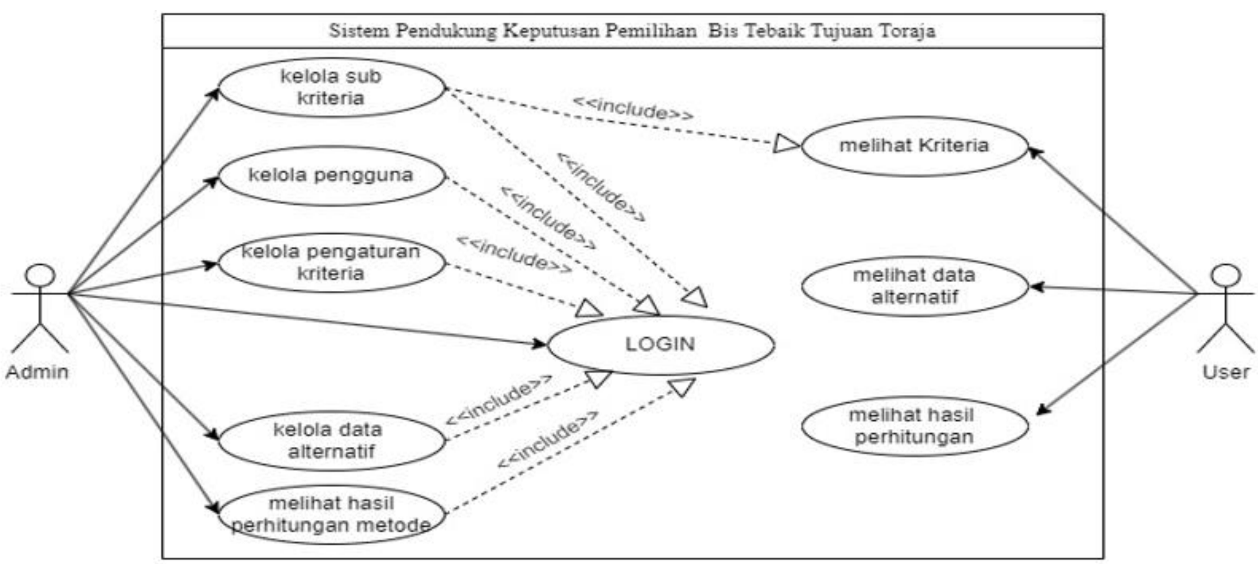

Figure 3. Stages of Research.

Hardware Requirements Analysis:

In the implementation of the decision support system for selecting the best bus to Toraja, the system requires specific minimum hardware specifications. These include an AMD Athlon Gold 3150U processor with a clock speed of 2.40 GHz, 8 GB of RAM, a 320 GB hard disk, a monitor, a mouse, a keyboard, and a printer. These hardware components are necessary for the proper functioning of the system.

Software Requirements Analysis:

To run the decision support system for selecting the best bus to Toraja, certain software components are required. The system utilizes PHP, HTML, MySQL, XAMPP, a web browser, CSS, and Bootstrap. These software tools enable the system to perform the necessary functions and provide an interactive user interface for decision-making processes.

Results and Discussion

Result

The research results are presented in full and by the scope of the study. The results of the research can be completed with tables, graphs (images), and/or charts. Tables and figures are numbered and titled. The results of the data analysis were interpreted correctly

(a) (b)

Figure 4. Dashboard Page and Criteria Page.

In Figure 4, part (a) shows the Dashboard page, which is the initial display when logged in as an admin. It contains several main menus, namely the dashboard, alternatives, criteria, and calculation results. Moving on to part (b) of Figure 4, the Criteria page displays the main interface as shown in the image. On this menu, the admin can add and edit criteria data that need to be added or modified.

(a) (b)

Figure 5. Alternative Page and Calculation Results Page.

In Figure 5, part (a) shows the Alternative page where the admin can add and edit alternatives from the bus list. Moving on to part (b) of Figure 5, this page displays the ranking results of each alternative.

Implementation of Weighted Product Method

The calculation testing will be performed on the data of candidate alternatives (Buses) and the criteria inputted by the user for each alternative.

Alternative Data

Table 1. Alternative Data.

Alternative Code	Alternative Name
A01	Litha & Co
A02	Primadona
A03	Metro Permai
A04	Manggala Trans
A05	Bintang Timur
A06	Borlindo
A07	Sinar Mudah
A08	Bintang Prima

Table 1 Alternative Data, provides information about alternative candidates (Buses) that will be evaluated using the Weighted Product Method. This table includes alternative codes and corresponding names. Each alternative is represented by a unique code, and their names indicate the bus company or service. The alternative data serves as the basis for comparing and selecting the best bus options for Toraja destinations.

Data Criteria

Table 2. Data Criteria.

Alternative Code	Alternative Name
C01	Price Suitability to Quality
C02	Choice of Business Type
C03	Provided Facilities
C04	Service
C05	Baggage Security

Table 2 Data Criteria, provides a list of criteria that will be used in evaluating choices. Each criterion is represented by a unique code and has a corresponding name. The criteria in this table include price compatibility with quality (C01), choice of a business type (C02), facilities provided (C03), service quality (C04), and luggage security (C05). These criteria will be used to assess and compare various aspects of the alternative bus options to make an informed decision.

After all the required data has been obtained, the next step is to perform calculations to determine the priority value of each alternative and perform ranking.

Determine the weight for each criterion.

Table 3. Weighting for C1 (price)

Price	Weight	Description	Weight Criteria
<100,000	1	Very less	Lowest
100,000 & <=150,000	2	Less	-
150,000 & <=200,000	3	Pair	-
200,000 & <=300,000	4	Good	-
300,000 & >400,000	5	Very good	Highest

Table 3 shows the weighting for criterion C1, which is related to the price of the alternatives. The table presents different price ranges along with their corresponding weights and descriptions. The weight represents the relative importance of each price range in the decision-making process. The description provides a qualitative assessment of each price range, ranging from "Very low" to "Very high". The "Criteria Weight" column indicates the overall weight assigned to this criterion.

Table 4. Weighting for C2-C5

Value	Weight	Description	Weight Criteria
<50	1	Very less	Lowest
51-65	2	Less	-
66-75	3	Pair	-
76-85	4	Good	-
86-100	5	Very good	Highest

Table 4 presents the weighting for criteria C2-C5. The table displays different value ranges, their corresponding weights, and descriptive labels. The weights indicate the relative importance of each value range within the specific criterion. The descriptions provide qualitative assessments of each range, ranging from "Very low" to "Very high". The "Criteria Weight" column represents the overall weight assigned to each criterion, indicating its significance in the decision-making process.

Table 5. Overall Weighting

Percentage (%)	Weight	Description	Weight Criteria
0	1	Very less	Lowest
5	2	Less	-
15	3	Pair	-
20	4	Good	-
25	5	Very good	Highest

Table 5 presents the overall weighting for the criteria. The table includes different percentage values, their corresponding weights, and descriptive labels. The weights indicate the relative importance of each percentage range in the decision-making process. The "Criteria Weight" column represents the weight assigned to each criterion, indicating its significance in the overall decision-making process. In this case, each criterion has a specific percentage weight assigned, and when combined, they sum up to 100%, representing the total weight distribution among the criteria.

In the decision-making process, preference weights are assigned to each criterion as follows:

C01 = 25%;
C02 = 20%;
C03 = 20%;
C04 = 20%; and
C05 = 15%;
TOTAL = 100%

This weighting shows the level of each criterion in the decision-making process. C01 has a 25% weight, C02 has a 20% weight, C03 has a 20% weight, C04 has a 20% weight, and C05 has a 15% weight. The total weight assigned to all criteria amounts to 100%, which represents the overall priority weight allocation in the decision-making process.

Table 5. Alternative Values in Each Criterion

Alternative	Criteria Name				
	C01	C02	C03	C04	C05
Litha & Co	5	5	5	5	4
Primadona	5	5	4	4	4
Metro Permai	4	5	4	4	4
Manggala Trans	4	4	4	4	4
Bintang Timur	4	4	5	5	5
Borlindo	5	5	4	4	4
Sinar Mudah	4	5	4	4	4
Bintang Prima	4	5	5	4	4

Table 6 displays the values assigned to each alternative for each criterion. The alternatives are listed in the leftmost column, while the criteria (C01, C02, C03, C04, C05) are listed in the respective columns. The values represent the assessment or rating of each alternative's performance in each criterion. For example, Litha & Co has a value of 5 for C01, C02, C03, and C04, and a value of 4 for C05. These values indicate the relative performance or suitability of each alternative for each criterion.

Next, we normalize the weights using Equation 1: W = (5, 4, 4, 4, 3)

W1 = 5 / (5 + 4 + 4 + 4 + 3) = 5 / 20 = 0.25
W2 = 4 / (5 + 4 + 4 + 4 + 3) = 4 / 20 = 0.2
W3 = 4 / (5 + 4 + 4 + 4 + 3) = 4 / 20 = 0.2
W4 = 4 / (5 + 4 + 4 + 4 + 3) = 4 / 20 = 0.2
W5 = 3 / (5 + 4 + 4 + 4 + 3) = 3 / 20 = 0.15

Based on the results from the equation above, the total value of all weights W is 1. So the value of W1 + W2 + W3 + W4 + W5 = 0.25 + 0.2 + 0.2 + 0.2 + 0.15 = 1.

Next, we determine the value of the S vector:

S1 = (350,000 * 0.25) + (95 * 0.2) + (87 * 0.2) + (88 * 0.2) + (85 * 0.15) = 704.3280
S2 = (300,000 * 0.25) + (90 * 0.2) + (84 * 0.2) + (80 * 0.2) + (83 * 0.15) = 650.8252
S3 = (200,000 * 0.25) + (87 * 0.2) + (79 * 0.2) + (77 * 0.2) + (80 * 0.15) = 569.4405
S4 = (200,000 * 0.25) + (83 * 0.2) + (80 * 0.2) + (79 * 0.2) + (81 * 0.15) = 569.4941
S5 = (250,000 * 0.25) + (85 * 0.2) + (87 * 0.2) + (89 * 0.2) + (88 * 0.15) = 638.0034
S6 = (350,000 * 0.25) + (91 * 0.2) + (84 * 0.2) + (82 * 0.2) + (82 * 0.15) = 680.0110
S7 = (250,000 * 0.25) + (89 * 0.2) + (82 * 0.2) + (83 * 0.2) + (80 * 0.15) = 618.5928
S8 = (250,000 * 0.25) + (88 * 0.2) + (90 * 0.2) + (81 * 0.2) + (87 * 0.15) = 633.6580

The next step is to calculate the relative preference value for each alternative:

V1 = S1 / (S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8)
= 704.3280 / (704.3280 + 650.8252 + 569.4405 + 569.4941 + 638.0034 + 680.0110 + 618.5928 + 633.6580)
= 0.13907
V2 = S2 / (S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8)
= 650.8252 / (704.3280 + 650.8252 + 569.4405 + 569.4941 + 638.0034 + 680.0110 + 618.5928 + 633.6580)
= 0.12851
V3 = S3 / (S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8)
= 569.4405 / (704.3280 + 650.8252 + 569.4405 + 569.4941 + 638.0034 + 680.0110 + 618.5928 + 633.6580)

= 0.11244
V4 = S4 / (S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8)
= 569.4941 / (704.3280 + 650.8252 + 569.4405 + 569.4941 + 638.0034 + 680.0110 + 618.5928 + 633.6580)
= 0.11245
V5 = S5 / (S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8)
= 638.0034 / (704.3280 + 650.8252 + 569.4405 + 569.4941 + 638.0034 + 680.0110 + 618.5928 + 633.6580)
= 0.12597
V6 = S6 / (S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8)
= 680.0110 / (704.3280 + 650.8252 + 569.4405 + 569.4941 + 638.0034 + 680.0110 + 618.5928 + 633.6580)
= 0.13427
V7 = S7 / (S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8)
= 618.5928 / (704.3280 + 650.8252 + 569.4405 + 569.4941 + 638.0034 + 680.0110 + 618.5928 + 633.6580)
= 0.12214
V8 = S8 / (S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8)
= 633.6580 / (704.3280 + 650.8252 + 569.4405 + 569.4941 + 638.0034 + 680.0110 + 618.5928 + 633.6580)
= 0.12512

After calculating the preference values for the alternatives, the ranking of the vector values (V) from highest to lowest is as follows:

Rank 1: V1 = 0.13907
Rank 2: V6 = 0.13427
Rank 3: V2 = 0.12851
Rank 4: V5 = 0.12597
Rank 5: V8 = 0.12512
Rank 6: V7 = 0.12214
Rank 7: V4 = 0.11245
Rank 8: V3 = 0.11244

So, it can be concluded that of the 8 (eight) buses to Toraja, the feasible alternative chosen is the 1st alternative, namely the Litha & Co bus.

Discussion

The research aimed to develop a Decision Support System (DSS) using the Weighted Product (WP) method for selecting the best bus destination for tourism purposes in Toraja. The utilization of the Weighted Product method in the DSS proved to be effective in handling the multi-criteria nature of the decision-making process. The method allowed for the consideration of various factors such as price, service quality, bus capacity, operational schedule, and level of comfort. By assigning appropriate weights to these criteria, the DSS calculated relative scores for each bus and facilitated the selection of the best bus destination.

The effectiveness of the Weighted Product method in multi-criteria decision-making is supported by previous research in the field. (Ginantra et al., 2020) conducted a study on destination selection for eco-tourism and implemented the Weighted Product method in their decision support system. Their findings demonstrated that the method successfully provided objective recommendations for selecting the best eco-tourism destinations based on criteria such as environmental sustainability, accessibility, cultural authenticity, and tourist satisfaction. The positive results of this study align with the outcomes of the current research, further validating the effectiveness of the Weighted Product method in decision support systems.

In addition, the research results of the current study are consistent with the research findings by (Zhao et al., 2019) on the selection of transport modes for business travel. (Zhao et al., 2019) used the Weighted Product method in their decision support system to evaluate criteria such as cost, travelling time, convenience, and safety. The results showed that this method effectively supports decision-making by providing objective recommendations for choosing the most suitable mode of transport. The similarity of these findings suggests that the Weighted Product method is applicable and effective in various decision contexts, including the selection of bus destinations for tourism purposes.

The research results provide objective and accurate recommendations for selecting the best bus destination. This can contribute to improving the overall travel experience and satisfaction of tourists visiting Toraja.

Conclusions and Suggestions

Conclusions

This study successfully developed a Decision Support System (SDM) using the Weighted Product (WP) method to select the best bus destination for tourism purposes in Toraja. The use of the WP method proved effective in handling a multi-criteria decision-making process by considering factors such as price, service quality, bus capacity, operational schedule, and comfort level. The DSS calculates the relative score for each bus based on predetermined criteria weights and provides an objective and accurate recommendation to select the best bus destination.

The results of this study contribute to improving the decision-making process for prospective travellers who will visit Toraja. The developed DSS assists in making informed decisions based on individual wants and needs, ultimately leading to improved travelling experience and satisfaction. The use of the WP method in the DSS enables comprehensive evaluation of various criteria, ensuring that all relevant factors are considered in the bus destination selection process.

Suggestions

Based on the research findings, some suggestions can be made for further improvement and application of the Decision Support System to select the best bus destination in Toraja:

1. As the tourism industry develops and customer preferences change, it is necessary to regularly review and update the criteria used in the SDM.
2. Incorporating real-time data into the DSS can improve its accuracy and relevance.
3. Building partnerships and collaborations with bus operators in Toraja can improve the accuracy and completeness of the data used in the DSS.

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