

Development of a Location-Aware Web-Based Decision Support System for Used Car Selection Using the SMART Method

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ABSTRACT

The development of information technology has significantly influenced the process of buying and selling vehicles, especially used cars. The process of selecting used cars often faces several problems, such as limited information, difficulties in comparing vehicle specifications, and different vehicle locations. This study aims to develop a location-aware web-based Decision Support System using the SMART (Simple Multi Attribute Rating Technique) method for used car selection. The system is designed to help users obtain the best used car recommendations based on several criteria, such as price, production year, engine condition, fuel consumption, transmission, mileage, and passenger capacity. The location-aware feature is implemented to allow users to search for used cars based on specific cities, such as Medan, Binjai, Pematang Siantar, and Sibolga. The SMART method is used to perform weighting and ranking of car alternatives to produce objective and measurable recommendations. This research uses data collection methods through literature studies, observations, and questionnaires distributed to 70 respondents. The results show that the developed system is capable of helping users choose used cars more effectively, efficiently, and according to user needs.

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1. INTRODUCTION

The development of information technology has had a significant impact on various aspects of life, including the process of buying and selling used vehicles. Today, people can easily obtain information about used cars through digital media and web-based platforms. Information systems have become important tools in supporting information management and delivery effectively [1]. In addition, website technology has experienced substantial development, ranging from HTML to HTML5, in supporting modern web application development [2].

In the process of selecting a used car, prospective buyers usually consider various criteria such as price, production year, engine condition, fuel consumption, transmission type, mileage, and passenger capacity. The large number of vehicle alternatives and the variety of criteria that must be considered make the decision-making process more complex. Therefore, a Decision Support System (DSS) is needed to assist users in determining the best choice objectively and efficiently [3].

A Decision Support System is a computer-based system used to support decision-making processes based on specific data and criteria [4]. One method that can be applied in DSS is the Simple Multi Attribute Rating Technique (SMART). SMART is a multi-criteria decision-making method that uses weighting and ranking processes to determine the best alternative based on the value of each criterion [5].

Several previous studies have demonstrated that the SMART method has been successfully implemented in various fields. Research conducted by Jemmyto applied the SMART method in determining recipients of food assistance and produced a more effective selection process [6]. Another study by Putranto and Maulina implemented the SMART method in a decision support system for selecting the best teachers [7]. Furthermore, research conducted by Suhardi et al. showed that the SMART method was able to provide objective recommendations in selecting favorite cafés [8]. Miftha and Saputra also applied the SMART method in a web-based decision support system for determining the eligibility of used motorcycle credit applications [9]. In addition, Raynor et al. developed a web-based implementation of the SMART method in a decision support system for smartphone selection according to community needs [10].

Based on previous studies, this research offers added value through the development of a location-aware web-based Decision Support System for used car selection. The proposed system not only provides vehicle recommendations using the SMART method but also presents vehicle location information in several cities, including Medan, Binjai, Pematang Siantar, and Sibolga. With this feature, users can more easily search for and select used cars according to their preferences and desired locations.

This study aims to develop a location-aware web-based Decision Support System using the SMART method for used car selection in order to make the search and decision-making process more effective, efficient, and objective.

2. THEORETICAL FOUNDATION AND RESEARCH METHODS

2.1 Decision Support System

A Decision Support System (DSS) is a computer-based information system designed to assist decision-makers in solving problems by utilizing data, models, and analytical techniques. DSS helps users evaluate alternatives and select the most appropriate solution based on predetermined criteria. The implementation of DSS has been widely applied in various fields to improve the effectiveness and efficiency of decision-making processes [4].

2.2 SMART Method

The Simple Multi Attribute Rating Technique (SMART) is a multi-criteria decision-making method used to determine the best alternative based on several evaluation criteria. SMART is considered effective because it has a simple calculation process, is flexible, and can generate objective recommendations through weighting and ranking mechanisms [5].

The SMART method consists of several stages, including determining criteria, assigning weights, normalizing weights, calculating utility values, and ranking alternatives. The alternative with the highest final score is selected as the best recommendation.

The normalization process is calculated using Equation (1):

(1)

$$\text{Normalization} = W_j / \sum W_j$$

Where:

W_j = weight of each criterion

$\sum W_j$ = total weight of all criteria

The utility value for benefit criteria is calculated using Equation (2):

(2)

$$u(a_i) = (C_{out} - C_{min}) / (C_{max} - C_{min})$$

The utility value for cost criteria is calculated using Equation (3):

(3)

$$u(a_i) = (C_{max} - C_{out}) / (C_{max} - C_{min})$$

Where:

$u(a_i)$ = utility value

C_{out} = alternative criterion value

C_{min} = minimum criterion value

C_{max} = maximum criterion value

The final SMART score is calculated using Equation (4):

(4)

$$V_i = \sum (w_j \times u_{ij})$$

Where:

V_i = final alternative score

w_j = normalized criterion weight

u_{ij} = utility value of alternative

The alternative with the highest score becomes the recommended option.

2.3 Data Collection Techniques

The data collection techniques used in this research include:

a. Observation

Observation was conducted to understand the process of selecting used cars and to identify problems faced by users when determining suitable vehicles according to their needs.

b. Questionnaire

Questionnaires were distributed to respondents to obtain information regarding the importance level of used car selection criteria, including price, production year, engine condition, fuel consumption, transmission type, mileage, and passenger capacity.

c. Literature Study

Literature studies were conducted by reviewing books, journals, and scientific publications related to Decision Support Systems, SMART methodology, web-based systems, and location-aware technology.

2.4 Evaluation Criteria

The criteria used in this study consist of:

1. Price
2. Production Year
3. Engine Condition
4. Fuel Consumption
5. Transmission Type
6. Mileage
7. Passenger Capacity

2.5 Research Stages

The stages of this research are as follows:

1. Problem Identification
2. Data Collection
3. System Requirement Analysis
4. Determination of Criteria and SMART Weights
5. System Design
6. System Implementation
7. System Testing
8. Conclusion

2.6 System Design

The proposed system was developed as a location-aware web-based application. The system utilizes PHP, MySQL, HTML, CSS, Bootstrap, and JavaScript technologies to manage vehicle data, perform SMART calculations, and provide location-based recommendations.

The system allows users to search for used cars according to specific criteria and locations, including Medan, Binjai, Pematang Siantar, and Sibolga. The recommendation process is performed automatically based on SMART calculations, resulting in objective and measurable rankings.

3. RESULTS AND DISCUSSION

3.1 Implementation of the SMART Method

The SMART (Simple Multi Attribute Rating Technique) method was implemented in the developed Decision Support System to assist users in selecting the most suitable used car based on multiple evaluation criteria. This method was chosen because it can provide objective ranking results through weighting and utility calculations.

The implementation process begins by determining the weight of each criterion based on questionnaire results and user requirements analysis. The criteria used in this study include price, production year, engine condition, fuel consumption, transmission type, mileage, and passenger capacity.

Table 1 shows the normalized weights used in the system.

Table 1. Normalized Criteria Weights

No	Criteria	Normalized Weight (wi)
1	Price	0.20
2	Production Year	0.15
3	Engine Condition	0.20
4	Fuel Consumption	0.10
5	Transmission	0.10
6	Mileage	0.15
7	Passenger Capacity	0.10
	Total	1.00

After determining the criterion weights, each used car alternative is evaluated according to the predefined criteria. The evaluation values are then converted into utility values to standardize different measurement scales.

For benefit criteria, higher values indicate better performance. In contrast, for cost criteria, lower values are preferred. The utility values are multiplied by their corresponding normalized weights to obtain weighted scores for each criterion.

For example, if a used car has a utility value of 0.8 for engine condition and the criterion weight is 0.20, then the weighted value is calculated as follows:

$$0.20 \times 0.80 = 0.16$$

The same calculation process is performed for all criteria and alternatives. The weighted values are then summed to obtain the final preference value (V_i). The alternative with the highest final score becomes the primary recommendation generated by the system.

The implementation of the SMART method enables the system to provide recommendations that are objective, measurable, and aligned with user preferences.

3.2 System Implementation

The developed application is a location-aware web-based Decision Support System designed to assist users in selecting used cars based on SMART calculations and location information.

3.2.1 Home Page

The home page serves as the main interface displayed when users access the application. This page provides general information regarding the system and introduces the main functionality of recommending used cars based on the SMART method.



Figure 1. Home Page Interface

3.2.2 Used Car Recommendation Page

The recommendation page displays a list of used cars ranked according to SMART calculation results. Each vehicle is presented in card format containing photographs, prices, locations, ratings, and detailed information. The system also provides location mapping features to support the location-aware concept implemented in this study.



Figure 2. Used Car Recommendation Page

3.2.3 Vehicle Detail Page

The vehicle detail page presents complete information about a selected used car, including vehicle specifications, condition, price, and geographic location.

Google Maps integration is also provided to allow users to access location information directly.

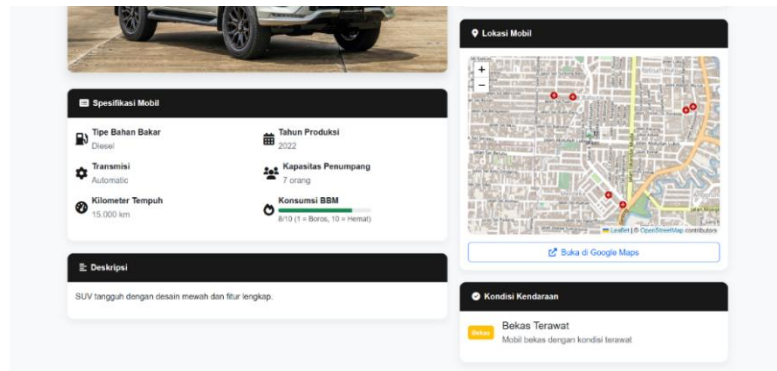


Figure 3. Vehicle Detail Page

3.2.4 Administrator Page

The administrator page is used to manage vehicle data, configure SMART criterion weights, and maintain the information required by the recommendation system.

This page ensures that all data used in the decision-making process remains accurate and up-to-date.

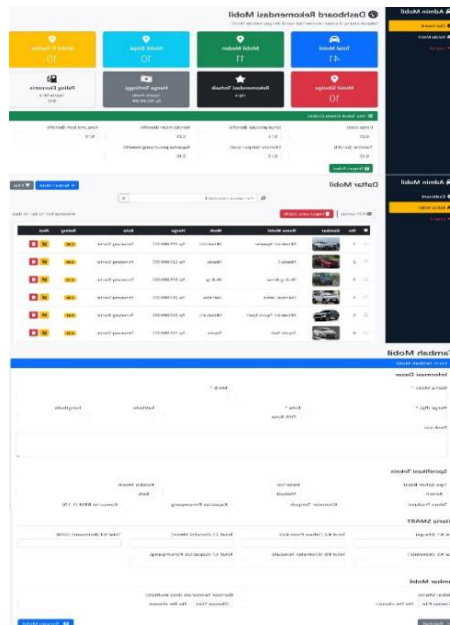


Figure 4. Administrator Page

3.3 Discussion

The implementation of the SMART method successfully supports the decision-making process for used car selection. The weighting and ranking mechanisms allow users to evaluate alternatives based on multiple criteria simultaneously.

The results indicate that criteria such as price and engine condition have the highest influence on recommendation outcomes because both criteria receive the largest normalized weights. This finding suggests that respondents consider affordability and vehicle condition as the most important factors when selecting used cars.

In addition, the location-aware feature provides significant advantages compared to conventional recommendation systems. Users can search for vehicles based on specific locations, including Medan, Binjai, Pematang Siantar, and Sibolga, making the selection process more relevant to user needs.

Compared with previous studies that focused only on SMART-based recommendations, this research integrates location information into the recommendation process. Therefore, the developed system not only ranks vehicle alternatives but also improves accessibility and convenience in finding suitable used cars.

3.4 Research Limitations

This study is limited to seven evaluation criteria and vehicle data obtained from four cities: Medan, Binjai, Pematang Siantar, and Sibolga. Future studies may include additional criteria and broader geographic coverage to improve recommendation accuracy and applicability.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Based on the results of the research and implementation of the location-aware web-based Decision Support System for used car selection using the SMART (Simple Multi Attribute Rating Technique) method, it can be concluded that the developed system is capable of assisting users in selecting used cars more quickly, objectively, and accurately.

The SMART method was successfully implemented in the ranking process based on predefined criteria, namely price, production year, engine condition, fuel consumption, transmission type, mileage, and passenger capacity. The calculation process generated preference values that were used as the basis for recommending the most suitable used car alternatives.

In addition, the implementation of the location-aware feature provides convenience for users in selecting vehicles based on specific locations, including Medan, Binjai, Pematang Siantar, and Sibolga. This feature makes the vehicle search process more relevant to user needs and geographical preferences.

Therefore, the developed system not only provides recommendations based on SMART calculations but also assists users in considering location aspects, resulting in more effective and appropriate decision-making when selecting used cars.

4.2 Recommendations

For future development, the system can be enhanced by expanding vehicle data coverage to include more cities and regions. Additional evaluation criteria such as vehicle maintenance history, ownership records, insurance status, and market value may also be incorporated to improve recommendation accuracy.

Furthermore, integration with real-time data from online used-car marketplaces and the development of a mobile-based application are recommended to increase accessibility and usability. Future studies may also compare the SMART method with other decision-support methods such as AHP, TOPSIS, SAW, and MOORA to evaluate recommendation performance and effectiveness.

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