Implementation of a Web-Based Application System for Recommending Optimal Car Engine Oil Selection Using the AHP and TOPSIS Methods (Case Study: Astrido Daihatsu Serpong)

Bagus Subekti[1], Muhammad Yasser Arafat[2]
Informatics Engineering Study Program, Faculty of Computer Science, Universitas Pamulang, South Tangerang, Indonesia

Selecting the appropriate engine oil is an important factor in maintaining vehicle engine performance, efficiency, and durability. However, the wide variety of engine oil products with different characteristics often causes the selection process to be carried out manually, resulting in less objective decision-making. This study aims to design and implement a web-based engine oil recommendation system using the Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods at Astrido Daihatsu Serpong. The AHP method is applied to determine the priority weights of each decision criterion, while the TOPSIS method is used to rank engine oil alternatives based on their closeness to the positive ideal solution and distance from the negative ideal solution. The system was developed using the Laravel framework and MySQL database based on the system development method adopted in this research. The implementation results indicate that the proposed system is capable of providing objective, accurate, and efficient engine oil recommendations according to predefined criteria. Furthermore, the system improves the efficiency of the recommendation process, assists technicians in providing appropriate recommendations to customers, and supports more consistent decision-making at Astrido Daihatsu Serpong.

Keywords: Decision Support System (DSS), Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Car Engine Oil Selection, Web-Based Application.

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Corresponding Author:
Bagus Subekti
Informatics Engineering Study Program, Faculty of Computer Science, Universitas Pamulang, South Tangerang, Indonesia
bagussubekti24@gmai.com

1. Introduction

The rapid growth of the automotive industry in Indonesia has led to numerous innovations, including a wide variety of vehicles and their supporting components. One of the most critical components that ensures optimal engine performance and prolongs engine lifespan is engine oil. Engine oil functions as a lubricant, coolant, cleaning agent, anti-corrosion protector, and sealant between engine components. However, the large number of engine oil brands and types with varying technical specifications, such as viscosity grades (SAE), quality standards (API, ACEA, and JASO), and additive compositions, often creates confusion among vehicle owners and technicians when selecting the most suitable and optimal engine oil. Incorrect engine oil selection can negatively affect engine performance, reduce fuel efficiency, and even cause long-term damage to engine components. This situation highlights the need for an accurate and efficient decision-making process. In practice, engine oil selection is often based on habit, informal recommendations, or incomplete information, which may lead to suboptimal decisions. Astrido Daihatsu Serpong, as one of the leading authorized Daihatsu dealerships and service centers, faces similar challenges in providing the best engine oil recommendations to its customers. With a wide range of Daihatsu vehicle models and diverse customer requirements, service staff are expected to deliver recommendations that are fast, accurate, and reliable. Manual recommendation processes may result in inconsistencies, require considerable time, and fail to provide optimal recommendations.

To address these challenges, a system capable of identifying and recommending the most appropriate engine oil based on multiple structured and complex criteria is required. A Decision Support System (DSS) provides a suitable solution for this problem. This study proposes the integration of the *Analytic Hierarchy Process* (AHP) and the *Technique for Order Preference by Similarity to Ideal Solution* (TOPSIS). The AHP method is employed to determine the priority weights of the evaluation criteria based on expert judgments, while the TOPSIS method is used to rank engine oil alternatives according to their proximity to the positive ideal solution and their distance from the negative ideal solution. The implementation of this system as a web-based application enhances accessibility and usability for both service staff and customers. Previous research has addressed engine oil selection using decision support systems. Marsela et al. developed a decision support system for selecting engine oil for Yamaha Mio motorcycles using the Analytical Hierarchy Process (AHP). The study demonstrated that AHP could be applied to identify priority criteria and support the selection of engine oil alternatives. However, the study employed AHP without integrating it with another ranking method such as TOPSIS [1].

The integration of AHP and TOPSIS has also been investigated in other decision-making contexts. Iswari et al. developed a decision support system for selecting outstanding students by combining AHP and TOPSIS. In their approach, AHP was used to determine criterion priorities through pairwise comparisons, while TOPSIS was employed to rank alternatives based on their distance from the positive and negative ideal solutions [2]. Meilani and Johansah subsequently applied the AHP–TOPSIS combination to the selection of official vehicles, demonstrating its application in automotive-related multi-criteria decision-making involving factors such as price, passenger capacity, fuel-tank capacity, and engine specifications [3]. More recently, Sya'Roni et al. applied AHP and TOPSIS to select work laptops, further demonstrating the use of the combined approach for ranking alternatives with diverse technical and economic characteristics [4]. Although these studies demonstrate the applicability of AHP–TOPSIS for multi-criteria decision-making, a research gap remains in the specific context of car engine oil selection at an authorized automotive service center. Existing research on engine oil selection has focused on Yamaha Mio motorcycles and applied AHP as the principal method [1], whereas previous studies integrating AHP and TOPSIS have addressed other selection problems, including outstanding student selection [2], official vehicle selection [3], and work laptop selection [4]. Therefore, limited research has specifically integrated AHP and TOPSIS to recommend car engine oil by simultaneously considering workshop-specific criteria such as oil price, SAE specification, stock availability, and manufacturer recommendation. This study addresses this gap by implementing the integrated AHP–TOPSIS approach in a web-based decision support system at Astrido Daihatsu Serpong. Based on the foregoing, this study aims to implement a web-based application for recommending the optimal selection of car engine oil using the AHP and TOPSIS methods, with a case study conducted at Astrido Daihatsu Serpong. The proposed system is expected to serve as an effective decision support tool for improving the accuracy, consistency, and efficiency of the engine oil selection process.

2. Methods

Current System

The current system analysis was conducted based on direct observations at the Astrido Daihatsu Serpong Workshop, interviews with Service Advisors (SA), and a study of the vehicle service manual and the recommended lubricant standards used by the workshop. The process begins when a customer arrives at the workshop for vehicle servicing. The Service Advisor receives the vehicle and records vehicle information, such as the vehicle type, engine capacity, year of manufacture, and service history. Based on this data and the customer's complaint, the Service Advisor determines the type of engine oil to recommend. In providing oil recommendations, the Service Advisor considers several key factors, including:

1. Vehicle specifications according to manufacturer standards
2. Type and viscosity of engine oil
3. Alternative oil brands available at the workshop
4. Customer preferences regarding brand or price

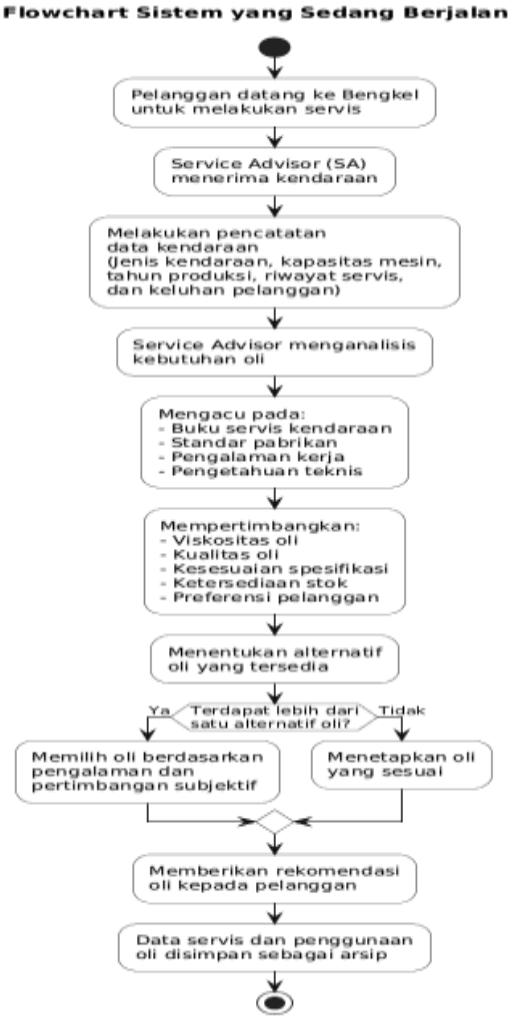


Figure 1. Flowchart of the running system

Requirements Analysis

Based on observations and interviews conducted at Astrido Daihatsu Serpong, vehicle service and engine oil usage data are recorded administratively but have not been utilized to support decision-making in selecting the most appropriate engine oil. Oil recommendations still rely on the experience and personal judgment of mechanics or Service Advisors, resulting in inconsistent recommendations for vehicles with similar characteristics. Furthermore, the selection process does not systematically evaluate important criteria, such as engine type, vehicle age, mileage, and oil viscosity/specifications. To address this issue, a web-based Decision Support System (DSS) integrating the AHP and TOPSIS methods is proposed. AHP is used to determine the priority weights of evaluation criteria, while TOPSIS ranks engine oil alternatives to identify the most suitable option. The system development includes analyses of hardware, software, and functional requirements to ensure that it meets user needs effectively.

Data Sources and AHP Assessment

The data used in this study were obtained through direct observation, interviews, and technical documentation at Astrido Daihatsu Serpong. Direct observation was conducted to identify the existing engine oil

recommendation process and the factors considered by the workshop personnel. Interviews were conducted with the Service Advisor (SA) to obtain information regarding the criteria used in selecting engine oil, while technical information was obtained from vehicle service manuals and lubricant recommendation standards used by the workshop. Based on the interviews with the Service Advisor and the review of vehicle lubricant characteristics, four criteria were established for the decision-making process: Oil Price (C1), SAE Specification (C2), Stock Availability (C3), and Manufacturer Recommendation (C4). Oil Price and Stock Availability were classified as cost criteria, whereas SAE Specification and Manufacturer Recommendation were classified as benefit criteria. Three engine oil alternatives were evaluated, namely Daihatsu Genuine Oil (A1), Astra Genuine Oil (A2), and Titan Oil Fuchs (A3).

The AHP weighting process was based on the assessment obtained from the Service Advisor involved in the engine oil recommendation process at Astrido Daihatsu Serpong. The Service Advisor was selected as the source of assessment because the role is directly involved in receiving vehicles, reviewing vehicle information, and determining engine oil recommendations based on vehicle characteristics and workshop requirements. The assessment was used to establish the relative importance of the four decision criteria through pairwise comparisons using Saaty's fundamental scale. The pairwise comparison values were organized into an AHP comparison matrix and subsequently normalized to obtain the priority weights of the criteria. The consistency of the resulting judgments was evaluated using the Consistency Index (CI) and Consistency Ratio (CR). A comparison matrix was considered acceptable when the CR value was less than or equal to 0.10. In this study, the resulting pairwise comparison matrix produced a CR value of 0.044, indicating that the judgments used for criterion weighting satisfied the required consistency condition. The resulting criterion weights were then used in the TOPSIS calculation to evaluate the performance of the three engine oil alternatives. The alternative performance data were entered according to the four predetermined criteria and subsequently processed through decision-matrix normalization, weighting using the AHP-derived priority values, determination of positive and negative ideal solutions, calculation of separation distances, and calculation of the preference value for each alternative.

Proposed System

The proposed system is a web-based application that provides objective engine oil recommendations using the AHP and TOPSIS methods. Users input vehicle and evaluation data, after which the system calculates criterion weights and ranks engine oil alternatives. The system workflow is summarized as follows:

1. Users log in through a web browser using a username and password.
2. After successful authentication, users can manage vehicle data, evaluation criteria, engine oil alternatives, pairwise comparison data for AHP, and alternative performance values.
3. The system validates data completeness before performing calculations. If data are incomplete, users are prompted to complete the required information.
4. The AHP process calculates criterion weights, including λmax (Lambda Maximum), Consistency Index (CI), and Consistency Ratio (CR). If CR ≤ 0.1, the comparison matrix is considered consistent; otherwise, users must revise the pairwise comparisons.
5. Once consistency is achieved, the TOPSIS process is executed by constructing the decision matrix, normalizing the data, applying AHP-derived weights, determining the positive and negative ideal solutions, calculating separation distances, computing preference values, and ranking the engine oil alternatives.
6. The calculation results are stored in the database, and the system displays the ranked recommendations. The alternative with the highest preference value is selected as the optimal engine oil recommendation.

3. Result And Discussion

System Implementation

The system implementation phase involves transforming the system analysis and design presented in Chapter III into a web-based application. The proposed application was developed to support decision-making in selecting the most appropriate car engine oil using the Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods. The implementation integrates the user interface, database, and the computational logic of the AHP and TOPSIS methods into a unified system [5]. The application enables administrators and users to manage engine oil alternatives, evaluation criteria, criterion weights, and the recommendation process. The system was developed using PHP as the programming language and MySQL as the database management system [6].

Implementation of Supporting Tools

The development, testing, implementation, and operation of the web-based engine oil recommendation system require both hardware and software support. Hardware provides the computing environment for system development and access, while software supports application development, database management, system testing, and deployment to a web hosting environment [7]. The hardware and software specifications used in this study are presented in the following table. The supporting tools utilized for system development include:

Table 1. Supporting Equipment

No.	Device/Software	Name
1	Laptop	Asus Vivobook i3
2	Web Server	XAMPP v3.3
3	Programming Language	Laravel
4	Database	MySQL
5	Text Editor	Visual Studio Code (VS Code), Antigravity
6	Web Browser	Google Chrome
7	Web Hosting	Jagoan Hosting

Based on Table 1, the software implementation of the car engine oil recommendation system utilizes several supporting software tools throughout the development, testing, and deployment processes [8]. The primary device used is an Asus Vivobook i3 laptop as the system development tool. The application development process utilizes the Laravel Framework, which implements a Model-View-Controller (MVC) architecture, simplifying code management and application feature development.



Figure 2. XAMPP Control Panel v3.3.0

XAMPP version 3.3 serves as the local web server, providing Apache, PHP, and MySQL services to run the application during the development and testing phase . Data storage is performed using MySQL as a database management system (DBMS), which stores all user data, vehicles, criteria, oil alternatives, and the calculation results of the Hybrid AHP and TOPSIS methods.

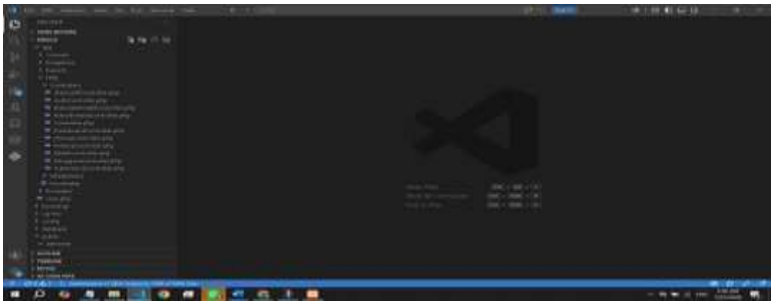


Figure 3. VSCode Text Editor

The process of writing and managing program code uses Visual Studio Code (VSCode) and Antigravity as text editors, which support various programming features, such as syntax highlighting, debugging, and integration with the Laravel framework, simplifying the application development process. Interface and system functionality testing was conducted using Google Chrome as a web browser to ensure all application features function properly.



Figure 4. Web Hosting

After the development and testing process was completed, the application was implemented on Jagoan Hosting's web hosting service so that the system could be accessed online via the internet. With this software support, the car engine oil recommendation system ran optimally and stably, providing oil recommendations based on the Hybrid AHP and TOPSIS methods according to user needs [9].

Database Implementation

Database implementation is the stage of applying the database design results to the system using MySQL as the Database Management System (DBMS). The database serves as the storage medium for all data used in the web-based car engine oil recommendation system [10]. The database implementation was carried out using the phpMyAdmin application, available on both local servers and web hosting environments. Each table was designed to be interconnected to support user authentication, vehicle data management, criteria data, alternative oil data, and calculations using the Hybrid AHP and TOPSIS methods [11]. The database used in the system is named siroli and consists of eight main tables: tbl_user, tbl_role, tbl_mobil, tb_kriteria, tb_rel_kriteria, tb_alternatif, tb_kinerja_alternatif, and tb_nilai_option. Each table has a different function but is integrated with each other to support data processing and generate engine oil recommendations appropriate to the vehicle's condition. The database implementation is based on the database design created in Chapter III. Each table has interconnected relationships, facilitating data processing within the system.

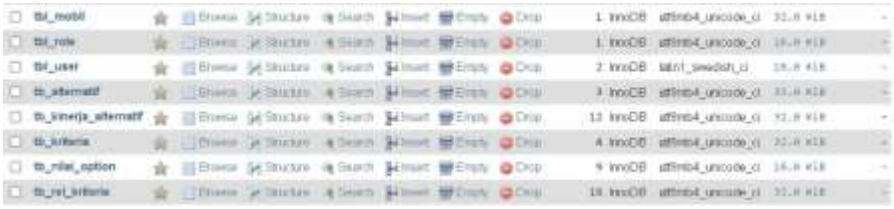


Figure 5. Database Tables

The main tables used in the system include:

1. tbl_user table
   The tbl_user table is used to store information about all users with access rights to the system. The stored data includes user identity, email address, encrypted password, access rights (role), and account status. This table is used in the authentication process so that only users with active accounts can access the application.
2. tbl_role table
   The tbl_role table is used to store user access rights. Each user in the tbl_user table has a role that determines which menus and features can be accessed within the system, such as Administrator or Service Advisor.
3. tbl_car table
   The tbl_car table is used to store vehicle data that is used in the engine oil recommendation process. Vehicle information, such as the car name and year of manufacture, is used as a reference in determining criteria and appropriate oil alternatives.
4. tb_criteria table
   The tb_criteria table is used to store all assessment criteria used in the recommendation process. Each criterion has a code, criterion name, and attribute in the form of Benefit or Cost, which will be used in the AHP and TOPSIS calculation processes.
5. tb_rel_criteria Table
   The tb_rel_kriteria table is used to store pairwise comparison values between criteria based on the Saaty scale. The data in this table is processed using the Analytical Hierarchy Process (AHP) method to generate priority weights for each criterion and to test the level of consistency using the Consistency Ratio (CR) value.
6. tb_alternative Table
   The tb_alternatif table is used to store data on the engine oil alternatives to be evaluated. In addition to storing the identity of each alternative, this table also stores the final preference value and ranking results obtained from the TOPSIS calculation process.
7. tb_kinerja_alternatif Table
   The tb_kinerja_alternatif table is used to store the values of each alternative against each assessment criterion. The data in this table forms a decision matrix, which is then processed using the TOPSIS method to determine the best oil alternative.

System Interface Implementation

The system interface implementation is based on the previously created user interface design. The system interface is designed to be easy to use, simple, and provide a good user experience.

1. Login Page
   The login page is the initial page used by users to log into the system. On this page, users are asked to enter the username and password registered in the database.



Figure 6. Login Form

If the login information is correct, the user will be directed to the dashboard page. However, if the data entered is incorrect, the system will display an error message.

2. Dashboard Page

   The dashboard page is the main page after a user successfully logs into the system. This page displays general information about the system as well as a navigation menu that can be used to access other features.



Figure 7. Dashboard

The dashboard page contains the following menus:

1) Alternative Data
2) Criteria Data
3) Criteria Weight
4) Alternative Value
5) Recommendation Results
6) User Data
7) Logout

3. Alternative Data Page

   The alternative data page is used to manage data on car engine oils used as alternatives in the recommendation process. On this page, the admin can add, edit, or delete alternative oil data.



Figure 8. Alternative Data

The alternative data entered includes:

1) Code
2) Oil Name
3) Action

4. Criteria Data Page

The criteria data page is used to manage the criteria data used in the assessment process. These criteria form the basis for determining the best oil.



Figure 9. Criteria Data

Examples of criteria used include:

1) Price
2) SAE Specifications
3) Stock Availability
4) Manufacturer Recommendations

5. Criteria Weighting Page

The criteria weighting page is used to conduct pairwise comparisons between criteria using the AHP method. The result of this process is the priority weight of each criterion.



Figure 10. Criteria Weighting

At this stage, the system will calculate:

1) Comparison Matrix
2) Matrix Normalization
3) Eigenvector
4) Consistency Index (CI)
5) Consistency Ratio (CR)

If the CR value is less than or equal to 0.1, the data is considered consistent and can be used for the next calculation process.

6. Alternative Values Page

The alternative values page is used to enter the values of each alternative against each criterion used in the system. The entered values will later be used in the TOPSIS calculation process to determine the best oil alternative.



Figure 11. Alternative Values

7. Recommendation Results Page
   The recommendation results page displays the final results of the AHP and TOPSIS calculation processes in the form of a ranking of engine oil alternatives. The system will display the preference values for each alternative and the order of the best oil recommendations based on the calculation results. The alternative with the highest preference value will be the primary recommendation suggested by the system.



Figure 12. Calculation Results

Implementation of AHP and TOPSIS Methods

In this study, the AHP method was used to determine the priority weights for each criterion, while the TOPSIS method was used to rank alternative engine oils based on their proximity to the ideal solution [12]. The combination of these two methods allows for a more objective and measurable decision-making process.

1. Problem Definition
   In the process of selecting car engine oil at the Astrido Daihatsu Serpong Workshop, customers often experience difficulty in determining the oil that best suits their vehicle's needs. The availability of various oil brands with different characteristics makes the selection process less objective when based solely on general recommendations or subjective considerations [13]. Therefore, a decision support system is needed that can help determine the most optimal car engine oil based on several criteria deemed important. To solve this problem, the Analytical Hierarchy Process (AHP) method was used to determine the importance or weight of each criterion, followed by the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method to rank the alternative oils based on the obtained weights.
2. Determining Decision Objectives
   The first step in the AHP method is determining the objectives to be achieved. In this study, the primary objective is to determine the best car engine oil recommendations that meet customer needs based on several predetermined criteria [14]. This objective becomes the primary focus of the decision-making process, so all criteria and alternatives are evaluated based on their contribution to achieving that objective.
3. Determining Criteria and Alternatives

Based on interviews with the Service Advisor at the Astrido Daihatsu Serpong Workshop and a literature review of vehicle oil characteristics, four criteria were determined to be used in the decision-making process:

Table 2. Determining Criteria

Code	Criteria Name	Attribute
C1	Oil Price	Cost
C2	SAE Specification	Benefit
C3	Stock Availability	Cost
C4	Manufacturer Recommendation	Benefit

In addition to determining the criteria, alternative oils that will be evaluated in this study were also determined, namely:

Table 3. Determining Alternative

Code	Alternative
A1	Daihatsu Genuine Oil
A2	Astra Genuine Oil
A3	Titan Oil Fuchs

4. Constructing a Decision Hierarchy Structure

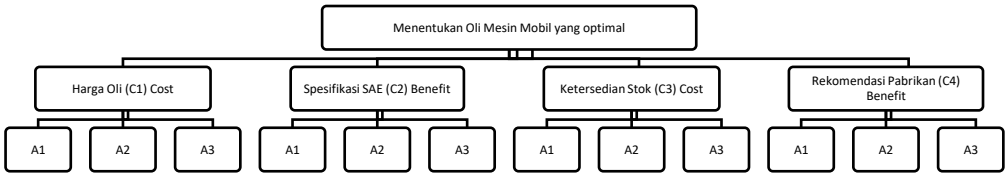


Figure 13. Decision Hierarchy Structure

The decision hierarchy structure in this study consists of three levels: objectives, criteria, and alternatives. The first level represents the research objective, which is to determine the optimal engine oil for use in customer vehicles. The second level consists of four criteria that influence the oil selection process: Oil Price (C1), SAE Specifications (C2), Stock Availability (C3), and Manufacturer Recommendations (C4). Furthermore, the third level consists of three oil alternatives to be evaluated: Daihatsu Genuine Oil from Daihatsu, Astra Genuine Oil from Astra International, and Titan Oil Fuchs from FUCHS Lubricants Indonesia. This hierarchical structure is used as the basis for the criteria weighting process using the AHP method before ranking the alternatives using the TOPSIS method.

5. Determining Element Priorities

The next stage is determining element priorities by conducting pairwise comparisons between criteria using the Saaty rating scale. Assessment is based on the level of importance of each criterion to the goal of selecting the best engine oil.

Table 4. Saaty's rating scale

Value	Interpretation
1	Equally Important
3	Slightly More Important
5	More Important
7	Much More Important
9	Absolutely More Important
2, 4, 6, 8	Intermediate values between two adjacent judgments

Based on the results of interviews and observations, the Oil Price (C1) criteria are considered slightly more important than SAE Specifications (C2) with a value of 3, more important than Stock Availability (C3) with a value of 5, and very more important than Manufacturer Recommendations (C4) with a value of 7. Furthermore, SAE Specifications (C2) are considered slightly more important than Stock Availability (C3) with a value of 3 and more important than Manufacturer Recommendations (C4) with a value of 5. Meanwhile, Stock Availability (C3) is considered slightly more important than Manufacturer Recommendations (C4) with a value of 3. The inverse value of each comparison is used to fill the symmetrical position in the matrix so that a pairwise comparison matrix is obtained that is reciprocal and meets the basic principles of the AHP method.

Website Deployment

Website deployment is the final stage of system implementation, in which the application is transferred from the local development environment (localhost) to a web hosting server, enabling online access via the Internet. This stage is carried out after the implementation and testing processes have been completed and all system functions operate according to user requirements [15]. In this study, the Web-Based Car Engine Oil Recommendation System Using the Hybrid AHP and TOPSIS Methods was developed using the Laravel framework, PHP programming language, and MySQL database. The application was then deployed to a compatible web hosting service and configured with a domain to provide online accessibility [16].



Figure 14. cPanel Jagoan Hosting

The deployment process begins by uploading all application source code to the hosting server. After the upload is complete, a database is created on the hosting server and all data previously used in the development environment is imported. The next step is to configure the .env file by adjusting the database connection parameters, the application address (APP_URL), and other necessary configurations to ensure the application runs properly on the hosting server.

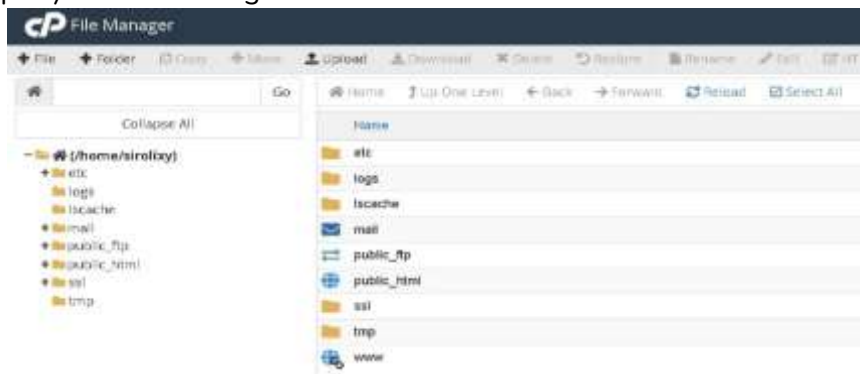


Figure 15. Cpanel File Manager

After deployment, the Laravel directory structure, particularly the public folder, was adjusted to match the web server configuration. Laravel optimization commands were then executed to improve application performance and page loading speed. The final stage involved retesting all system features on the hosting server, including user authentication, master data management, AHP-based criteria weighting, TOPSIS-

based alternative ranking, and the display of engine oil recommendations. The testing results confirmed that all functions operated successfully without errors, indicating that the system was properly deployed in the hosting environment. Through this deployment process, the application became accessible online via a web browser from any Internet-connected device, rather than being limited to local use. This enables administrators and Service Advisors to efficiently manage vehicle and engine oil data while obtaining fast, consistent, and objective recommendations based on the Hybrid AHP–TOPSIS method. Documentation of the successful website deployment is presented in Figure 16.



Figure 16. Website accessible in a browser

System Testing

System testing was conducted using the Black Box Testing method. This method is used to test system functions based on input and output without considering the program code used. The goal of testing is to ensure all system features operate according to user requirements.

Table 5. Black Box Testing

Module/Scenario	Test Description	Status	Test Result Notes
Middleware Protection	Tested direct access to /dashboard without logging in.	Successful	Redirected back to the login page (/).
Login Authentication	Logged in using the email admin@localhost.com and password admin123.	Successful	Login succeeded, session created, and redirected to the dashboard.
Dashboard View	Accessed the main dashboard page after logging in.	Successful	Page loaded successfully (HTTP 200).
Profile View	Accessed the administrator profile menu.	Successful	Profile page loaded successfully (HTTP 200).
Car CRUD (Create)	Added a new car record (Xenia, 2020, Type X).	Successful	Car data successfully added to the database.
Car CRUD (Update)	Updated the car name to Xenia 1.3 and the description to Type R.	Successful	Car data updated successfully.
Criteria CRUD (Create)	Added a new criterion C1 (Maintenance Cost, Cost) for the new car.	Successful	Criterion C1 successfully saved.
Criteria CRUD (Update)	Updated the criterion name to Updated Maintenance Cost.	Successful	Criterion name successfully updated to Updated Maintenance Cost.
Alternative CRUD (Create)	Added a new alternative A1 (Shell Helix HX7).	Successful	Alternative A1 successfully saved.

Module/Scenario	Test Description	Status	Test Result Notes
Alternative CRUD (Update)	Updated the alternative name to Shell Helix HX7 Plus.	Successful	Alternative updated successfully.
Criteria Weighting	Updated the pairwise comparison matrix for the criteria (C1 vs. C1 = 1).	Successful	Criteria comparison matrix updated successfully.
Alternative Weighting	Entered the alternative performance value (A1 for C1 = 8.5).	Successful	Alternative performance value updated successfully.
User CRUD (Create)	Added a new user tester@localhost.com.	Successful	New user successfully added.
User CRUD (Update)	Updated the user name to Tester User Updated.	Successful	User data updated successfully.
User CRUD (Delete)	Deleted Tester User Updated from the database.	Successful	User data successfully deleted.
Alternative CRUD (Delete)	Deleted alternative A1 from the database.	Successful	Alternative A1 successfully deleted.
Criteria CRUD (Delete)	Deleted criterion C1 from the database.	Successful	Criterion C1 successfully deleted.
Car CRUD (Delete)	Deleted Xenia 1.3 from the database.	Successful	Car data successfully deleted.
AHP Decision Support System Calculation	Performed the AHP-TOPSIS calculation using a car with complete data (Sigra 1.2).	Successful	Results page loaded successfully, displaying the ranking with Titan Oil Fuchs 0W-20 as the best alternative (Preference Score: 0.6296).
Logout	Ended the user session by accessing /logout.	Successful	Session terminated and redirected to the login page.

Based on all functional test scenarios that have been executed, the system is declared free from critical issues, page errors, and AHP-TOPSIS calculation logic failures. The application functions well and is highly suitable for use. The AHP calculation produced four criterion weights, namely Oil Price (C1) of 0.558, SAE Specification (C2) of 0.263, Stock Availability (C3) of 0.122, and Manufacturer Recommendation (C4) of 0.057. The Consistency Ratio (CR) obtained was 0.044, which is below the maximum threshold of 0.10. This indicates that the pairwise comparison judgments were sufficiently consistent and could be used in the subsequent TOPSIS calculation. The weighting results indicate that Oil Price (C1) was the most influential criterion, with a weight of 55.8%. This finding indicates that price has the greatest relative contribution to the decision-making process in the proposed model. SAE Specification (C2) was the second most important criterion, with a weight of 26.3%, showing that technical suitability based on SAE specification remains an important consideration after price. Meanwhile, Stock Availability (C3) contributed 12.2%, while Manufacturer Recommendation (C4) had the lowest weight at 5.7%. Therefore, the weighting structure indicates that the decision process places greater relative emphasis on economic considerations and SAE specifications than on stock availability and manufacturer recommendation [17].

The dominance of Oil Price in the AHP weighting can be related to the pairwise assessment used in the study. Oil Price was considered more important than SAE Specification, Stock Availability, and Manufacturer Recommendation, with respective Saaty values of 3, 5, and 7. This resulted in a substantially higher

priority weight for C1 than for the other criteria. The result demonstrates how expert judgment in the AHP stage directly influences the subsequent TOPSIS ranking because the resulting weights are applied to the normalized performance values of each alternative. The TOPSIS calculation produced three alternative preference values. Astra Genuine Oil (A2) obtained the highest preference value of 0.65199, followed by Titan Oil Fuchs (A3) with 0.57579, while Daihatsu Genuine Oil (A1) obtained 0.22011. Therefore, A2 was positioned as the first-ranked alternative in the proposed decision model. The first ranking of A2 can be explained by considering the combined performance of the alternative across all weighted criteria rather than by examining a single criterion. In the alternative assessment matrix, A2 obtained a value of 8 for Oil Price, compared with 10 for A1 and 9 for A3. Since Oil Price is categorized as a cost criterion, the lower value provides a more favorable contribution to the TOPSIS calculation. A2 also obtained a value of 8 for Stock Availability, compared with 9 for A1 and 10 for A3. However, A2 did not obtain the highest values for the benefit criteria. Its SAE Specification and Manufacturer Recommendation values were 7 and 6, respectively, whereas A3 obtained 9 and 8. This condition demonstrates the importance of integrating AHP and TOPSIS. Although A2 does not dominate all individual criteria, its relatively favorable performance on the criteria receiving substantial weights enables it to achieve the highest overall preference value. The TOPSIS calculation shows that A2 had a distance of 0.03895 from the positive ideal solution and 0.07297 from the negative ideal solution. These distances resulted in a preference value of 0.65199, which was higher than A3 and A1. Thus, the result should be interpreted as an overall trade-off between criterion importance and alternative performance rather than as an indication that A2 is the highest-performing alternative on every criterion.

The findings are consistent with previous studies demonstrating the application of AHP for multi-criteria engine oil selection. Marsela *et al.* applied AHP to the selection of engine oil for Yamaha Mio motorcycles and demonstrated that the method can be used to determine priorities among alternatives based on several selection criteria [1]. However, that study focused on motorcycle engine oil selection using AHP, whereas the present study applies a hybrid AHP-TOPSIS approach to car engine oil selection in an authorized automotive workshop. The present findings are also consistent with the research of Iswari *et al.*, which applied the AHP-TOPSIS combination for outstanding student selection [2]. In that study, AHP was used to determine the priority weights of the criteria, while TOPSIS was subsequently applied to rank alternatives according to their relative distance from the positive and negative ideal solutions. A similar methodological structure was applied in the present study, with AHP determining the relative importance of the engine oil selection criteria and TOPSIS determining the final ranking of the oil alternatives [18].

AHP-TOPSIS has also been applied to vehicle selection. Meilani and Johansah developed a decision support system for official vehicle selection using the AHP-TOPSIS method [3]. Their study demonstrates that the integration of AHP and TOPSIS can support multi-criteria selection by separating the process of determining criterion importance from the process of ranking alternatives. In the present study, this approach is adapted to the engine oil selection context, where the criteria consist of Oil Price, SAE Specification, Stock Availability, and Manufacturer Recommendation. Furthermore, Sya'Roni *et al.* applied AHP and TOPSIS to work-laptop selection and demonstrated the applicability of the hybrid method to alternative-selection problems involving multiple criteria [4]. Similar to the present study, the AHP stage determines the criterion weights before the TOPSIS stage evaluates the relative performance of the alternatives [19].

The comparison with these previous studies indicates that the contribution of the present research lies not only in the use of AHP-TOPSIS but also in its application to car engine oil selection within an authorized automotive workshop context [20]. Previous research has demonstrated the use of AHP for engine oil selection [1] and the AHP-TOPSIS combination for other selection problems such as student selection [2],

vehicle selection [3], and laptop selection [4]. In contrast, this study integrates the two methods to determine engine oil recommendations based on workshop-specific criteria and implements the calculation in a web-based decision support system. This contextual adaptation allows the resulting recommendation to be explained through explicit criterion weights and alternative preference values rather than relying solely on manual judgment [21]. Overall, the results demonstrate that the AHP-TOPSIS approach provides a structured mechanism for interpreting the engine oil selection problem. The AHP results show that Oil Price (0.558) and SAE Specification (0.263) represent the two most influential criteria, while Stock Availability and Manufacturer Recommendation have smaller relative weights. The TOPSIS results subsequently integrate these weights with the performance of each alternative and produce A2 as the highest-ranked alternative with a preference value of 0.65199. Therefore, the ranking of Astra Genuine Oil (A2) should be understood as the outcome of the combined weighting and ranking process. Its first position does not indicate superiority on every individual criterion; rather, it reflects its overall proximity to the positive ideal solution and distance from the negative ideal solution after the AHP-derived criterion weights have been incorporated [22].

4. Conclusion

Based on the results of the analysis, design, implementation, and testing of the web-based car engine oil recommendation system using the hybrid Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods at Astrido Daihatsu Serpong, the following conclusions can be drawn:

1. The web-based engine oil recommendation system was successfully designed and developed using the hybrid AHP and TOPSIS methods. The system was developed using the PHP programming language and MySQL database. AHP was implemented to determine the priority weights of the decision criteria, while TOPSIS was used to rank the engine oil alternatives. The system provides several functions, including engine oil alternative management, criteria management, AHP pairwise comparison input, alternative performance input, automatic AHP-TOPSIS calculations, and presentation of recommendations based on preference values. These functions demonstrate that the proposed system successfully addresses the objective of developing a web-based engine oil recommendation system.
2. The system generates engine oil recommendations based on the predefined criteria through a consistent mathematical decision-making process. The AHP calculation produced a Consistency Ratio (CR) of 0.044, which is below the acceptable threshold of 0.10, indicating that the pairwise comparison matrix was sufficiently consistent. The resulting criterion weights were 0.558 for Oil Price, 0.263 for SAE Specification, 0.122 for Stock Availability, and 0.057 for Manufacturer Recommendation. In the TOPSIS stage, Astra Genuine Oil (A2) obtained the highest preference value of 0.65199, followed by Titan Oil Fuchs (A3) with 0.57579 and Daihatsu Genuine Oil (A1) with 0.22011. These results indicate that the recommendation is determined by the combined influence of criterion weights and alternative performance rather than by a single criterion.
3. The implementation of the system supports a more structured and transparent engine oil recommendation process at Astrido Daihatsu Serpong. System testing showed that the developed application modules functioned according to their intended purposes. The integration of AHP and TOPSIS provides a systematic calculation procedure that can support workshop personnel in evaluating alternatives based on predetermined criteria. The web-based implementation also facilitates data management and the presentation of recommendation results compared with a recommendation process that relies primarily on manual assessment.
4. This study has several limitations that should be considered when interpreting the results. First, the analysis was conducted using a limited number of engine oil alternatives, consisting of Daihatsu Genuine

Oil, Astra Genuine Oil, and Titan Oil Fuchs. Therefore, the resulting ranking represents the alternatives included in the current study and should not be generalized to all engine oil products. Second, the decision model uses four criteria, namely Oil Price, SAE Specification, Stock Availability, and Manufacturer Recommendation. Other factors that may be relevant to engine oil selection, such as vehicle mileage, engine condition, oil performance specifications, operating conditions, and lubricant service interval, were not incorporated into the current model. Third, the AHP pairwise comparison and alternative assessment are dependent on the judgments and assessment data used in the study. Consequently, changes in the assessment values or criterion priorities may result in different preference values and rankings. Finally, the system was developed and evaluated within the context of Astrido Daihatsu Serpong, so its applicability to other workshops or service centers may require further adaptation and validation.

5. Future system development should focus on expanding the decision model and improving the adaptability of the recommendation system. The system can be enhanced by adding more engine oil brands and product variants so that a broader range of alternatives can be evaluated. Additional criteria can also be incorporated, particularly vehicle mileage, engine condition, operating characteristics, lubricant performance specifications, and recommended replacement intervals, provided that reliable assessment data are available. Furthermore, future development could include a more comprehensive vehicle database that automatically matches vehicle type, engine capacity, production year, and manufacturer specifications with suitable oil alternatives. The system could also be enhanced with user access management, historical recommendation records, reporting features, and periodic updating of oil prices and stock availability. Future studies may additionally evaluate the system using a larger set of alternatives and assessment data to examine the stability of the resulting recommendations.

Overall, the developed system demonstrates the applicability of the hybrid AHP-TOPSIS approach for structuring the engine oil recommendation process at Astrido Daihatsu Serpong. The combination of AHP-based criterion weighting and TOPSIS-based alternative ranking provides an explicit calculation framework through which the recommendation results can be traced to the defined criteria and assessment data. Nevertheless, further development and validation are required to accommodate a wider range of products, criteria, vehicle conditions, and operational contexts.

5. References

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