Published online on the page : https://journal.makwafoundation.org/index.php/intellect

I n t e l l e c t :

Indonesian Journal of Learning and Technological Innovation

| ISSN (*Online*) 2962-9233 |

Development and Preliminary Evaluation of an AHP-Based Decision Support System for Prioritizing Students for Free School Bus Services

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Article Information

Article History:
Submitted: May 1, 2026
Revised: June 21, 2026
Accepted: June 29, 2026
Published: June 30, 2026

Keywords

decision support system, analytic hierarchy process, school transportation, student prioritization, educational service allocation.

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A B S T R A C T

This study developed and conducted a preliminary evaluation of a web-based decision support system for prioritizing students eligible for free school bus services at SMP Negeri 10 Payakumbuh, Indonesia. The system applies the Analytic Hierarchy Process (AHP) to three locally defined criteria: residential distance, household economic circumstances, and student discipline. Development followed a Waterfall process using Laravel and MySQL. The reported evaluation comprised 12 black-box test scenarios, content-validity ratings from two university experts and two teachers, practicality ratings from one teacher and ten students, and a G-Score assessment involving one teacher and 36 students. All reported black-box scenarios passed; the instrument scores were Aiken's V = 0.889, kappa = 0.974, and G-Score = 0.935. These preliminary measures do not, on their own, establish faster selection, equitable allocation, or improved educational outcomes. The AHP outputs and resulting student rankings require verification against the original pairwise-comparison matrices and assessment records. The study contributes a documented prototype for structuring school transportation allocation decisions.

Abstrak

Penelitian ini mengembangkan dan mengevaluasi secara awal sistem pendukung keputusan berbasis web untuk menyusun prioritas siswa calon pengguna bus sekolah gratis di SMP Negeri 10 Payakumbuh. Sistem menggunakan Analytical Hierarchy Process (AHP) dengan tiga kriteria yang ditetapkan pihak sekolah: jarak rumah, kondisi ekonomi, dan kedisiplinan. Pengembangan mengikuti model Waterfall menggunakan Laravel dan MySQL. Tahap evaluasi yang dilaporkan meliputi 12 skenario black-box, penilaian validitas isi oleh dua dosen dan dua guru, penilaian praktikalitas oleh satu guru dan sepuluh siswa, serta pengukuran G-Score oleh satu guru dan 36 siswa. Seluruh skenario black-box dinyatakan valid; skor yang dilaporkan berturut-turut adalah Aiken's V 0,889, momen kappa 0,974, dan G-Score 0,935. Angka-angka tersebut merupakan hasil evaluasi awal sesuai instrumen yang digunakan, bukan bukti langsung peningkatan akses pendidikan, kecepatan seleksi, atau keadilan alokasi. Keluaran numerik AHP dan peringkat siswa masih memerlukan verifikasi terhadap matriks perbandingan serta data penilaian asli. Kontribusi penelitian adalah prototipe alur keputusan yang terdokumentasi untuk layanan transportasi pendidikan.

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1. Introduction

Transportation to school is an important practical condition for access to education, especially for students facing financial constraints, long distances, or limited travel options. Hopson et al.'s systematic review found varied relationships between school transportation and academic outcomes; the availability of a bus service should therefore not be equated with improved learning outcomes [1]. Quasi-experimental evidence from Edwards suggests that eligibility for transportation services may be associated with better attendance among economically disadvantaged students, but does not establish

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an overall improvement in academic achievement [2]. Research on mobility equity likewise shows that transportation disparities reflect family circumstances, neighborhood conditions, and service policies, rather than distance alone [3]. SMP Negeri 10 Payakumbuh provides free school bus services, but limited capacity requires the school to prioritize prospective users. This study examines that decision-making process rather than changes in attendance or learning outcomes.

The school reportedly selected bus users through deliberation, considering students' distance from home, economic circumstances, and discipline. Although this process draws on local knowledge, it does not produce explicit criterion weights or a structured decision record. Previous research indicates that household vehicle access and route characteristics can constrain school options that are formally available [4]. In Detroit, school transportation availability was associated with the likelihood of choosing a school served by the system, although the strength of this relationship varied with service design and neighborhood context [5]. Other work on school transportation policy suggests that equitable access is not always an explicit consideration in decision-making [6]. Accordingly, this study examines how locally defined criteria can be translated into an auditable prioritization model while recognizing the risk of overlooking vulnerable students. Verifiable figures for bus capacity and the duration of the previous selection process are not reported and require documentation from the authors.

A decision support system (DSS) can structure multicriteria decisions, although its outputs remain dependent on indicator selection, stakeholder judgments, and data quality. Software engineering principles and the use of technology in educational services provide a basis for developing a web-based application [7], [8]. In the context of student travel, studies of student mobility and school bus management point to the need to relate technical decisions to service availability and user needs [9], [10]. The Analytic Hierarchy Process (AHP) organizes goals, criteria, and alternatives into a hierarchy and uses pairwise comparisons to derive priorities; applications have been reported in transportation and educational selection [11], [12], [13]. Research on transportation route evaluation shows that AHP can organize assessments across multiple attributes, but the resulting rankings do not necessarily measure equitable service allocation [14]. Computational validation must therefore be distinguished from assessing recipients' needs.

Previous educational DSS studies have applied AHP to selecting exemplary students, allocating student assistance, choosing academic pathways, and comparing higher education institutions. These applications differ from bus seat allocation in their decision units, criteria, and evaluation evidence [15], [16], [17], [18], [19], [20]. Studies of school transportation have investigated access, mobility, and school choice [21], [22], [23], [24], whereas school bus optimization research has focused on stop selection, passenger grouping, and vehicle routing [25]. These strands of research address three distinct problems: access to a service, optimization of vehicle movement, and prioritization of individuals when capacity is limited. The present study addresses the third problem by organizing three criteria already used by the school into an initial assessment structure. A different application context does not, by itself, establish methodological novelty. The identifiable contribution lies in representing local rules in a DSS workflow, documenting the decision process, and conducting a preliminary prototype evaluation.

Conceptually, prioritizing bus seats is an educational service allocation problem involving potential benefits, capacity constraints, and risks of inequity. Research on barriers to attendance highlights the importance of school and family support tailored to students' individual circumstances [26], [27]. AHP results also need to be interpreted in light of uncertainty in group judgments and possible rank changes when weights or alternatives vary [28], [29], [30]. The gap addressed here is not the absence of AHP applications in schools, but the need to represent the selection process for free school transportation at a particular school in a system that produces structured recommendations. The contribution that can presently be supported is the design and preliminary evaluation of the software; fairness, ranking accuracy, and educational impacts require further testing.

Against this background, the study aims to (1) develop a web-based DSS that represents the school's criteria for prioritizing free school bus users at SMP Negeri 10 Payakumbuh through AHP; (2) describe the assessment workflow, pairwise comparisons, and ranking outputs; and (3) report the functional testing and preliminary product evaluation results. The Waterfall model provides the software development workflow. The intended practical contribution is a documented decision-support prototype. The mathematical validity of its weights, the appropriateness of the criteria, and its operational impact cannot be considered established until the underlying evidence is available.

2. Research Methodology

2.1. Research Design

The study is reported as research and development (R&D), with the Waterfall model providing the sequence of software engineering activities. Requirements analysis, design, development, testing, and maintenance are described to explain how the DSS prototype was constructed. Software engineering literature provides a rationale for a staged process, but adopting that model does not itself demonstrate successful implementation [7], [31]. Functional performance and the accuracy of AHP-based decisions require separate evaluation.

During requirements analysis, the authors report gathering information from school personnel and related agencies. This information informed user roles, criterion and alternative data structures, and the display of ranking results. The software development process is described within the system development life cycle (SDLC), with Waterfall as the selected model; other development models are not discussed because they were not used in this study [32], [33]. Software version information, records of requirement changes, and testing logs should be supplied from project documentation where available.

System development followed the Requirements Analysis, Design, Development, Testing, and Maintenance stages illustrated in Figure 1. The evidence associated with each stage should be identified explicitly, such as interview findings for requirements, design artifacts for system architecture, and test scenarios for testing. Other information system studies have likewise used Waterfall to sequence development activities, but product quality must be demonstrated through tests aligned with user needs [34], [35].

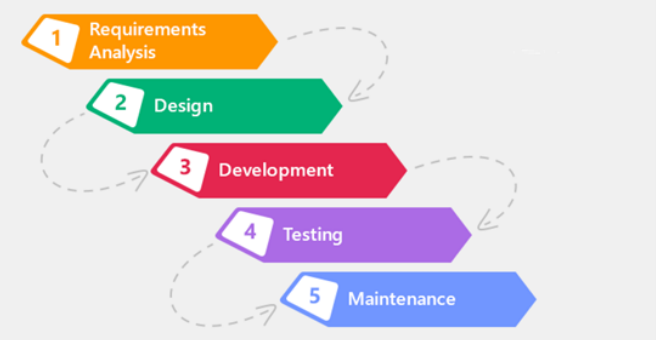


Figure 1. Waterfall stages [34]

2.2. Research Setting and Participants

The study was conducted at SMP Negeri 10 Payakumbuh, which provides free school bus services but reportedly continued to prioritize users manually. Participants were grouped according to the stage of the research in which they were involved.

During requirements analysis, participants comprised the vice principal for facilities and infrastructure (Waka Sarpras), the vice principal for curriculum, and a representative of the Payakumbuh City Transportation Office. These three individuals were purposively selected because of their direct involvement in managing school bus services and their familiarity with the criteria used to

prioritize users. The resulting observations and interview findings were subsequently endorsed by the principal of SMP Negeri 10 Payakumbuh, who was responsible for school policy.

For product evaluation, participants were selected according to their role in assessing the system: (1) the Aiken's V validity assessment involved two university lecturers in computing and two teachers from SMP Negeri 10 Payakumbuh as expert raters, selected for their software engineering expertise and understanding of users' local needs; (2) the practicality assessment, calculated using the reported kappa statistic, involved one teacher and ten students who used the system directly and assessed its operational ease of use; and (3) the evaluation using G-Score involved one teacher and 36 students to assess reported changes in the efficiency of prioritizing school bus users relative to the previous manual process.

All evaluation participants were purposively selected on the basis of their direct involvement as stakeholders in school bus user selection, whether as decision-makers, system users, or specialists qualified to assess the product.

2.3. System Development Procedure

2.3.1. Requirement Analysis

At this stage, developers communicate with users to understand the expected software and its constraints. Information may be collected through surveys, interviews, or discussions and is then examined to identify users' data requirements.

2.3.2. Design

At this stage, the developers prepare the system design, identify hardware and system requirements, and define the overall system architecture.

2.3.3. Development

At this stage, the system is developed as smaller program components, or units, which are subsequently integrated. Each unit is developed and its functionality checked through unit testing.

2.3.4. Testing

At this stage, the system is verified and tested to establish whether its components and overall operation meet the specified requirements. Testing encompasses unit tests of individual code modules, system tests of integrated modules, and acceptance testing with users to assess whether their requirements have been met.

2.3.5. Maintenance

Maintenance is the final Waterfall stage, during which the developed software is deployed and maintained. Maintenance includes correcting problems that were not identified in earlier stages.

2.4. AHP Decision Model

The decision model uses the Analytic Hierarchy Process (AHP) to organize the goal of prioritizing school bus users, three main criteria, and student alternatives. The criteria of residential distance, household economic circumstances, and discipline are reported to have been derived from observations and interviews with school stakeholders. Under AHP, priority weights should be obtained from pairwise-comparison matrices and reported separately from consistency measures or intermediate computational outputs [11], [29]. Including discipline requires an explicit policy justification: if this criterion reduces access for students with the greatest transportation needs, that risk should be identified and considered in a fairness evaluation. Sensitivity analysis of weight changes and the inclusion of multiple raters would be relevant extensions of the study [28], [30].

The AHP decision-making procedure reported in this study comprised the following stages:

(1) Define the decision hierarchy, including the goal, criteria, subcriteria, and student alternatives; (2) obtain pairwise comparisons using Saaty's 1–9 importance scale; (3) derive the priority vector from the normalized matrix; (4) calculate the Consistency Index (CI) and Consistency Ratio (CR) to assess judgment consistency; (5) calculate alternative scores by aggregating criterion weights and alternative values; and (6) rank those scores to generate recommendations. This sequence describes the authors' reported model. The original comparison matrices, normalized priority vectors, and calculations for individual alternatives were not included among the supporting materials; the numerical accuracy of the outputs in Tables 1 and 2 therefore could not be independently audited.

2.5. Research Instruments

The study employed the following instruments:

(1) An interview guide and observation sheet to examine the existing school bus selection procedure and the criteria used; (2) an AHP pairwise-comparison form to collect stakeholders' judgments about the relative importance of criteria and subcriteria; (3) an expert validation sheet analyzed using Aiken's V to assess content, interface presentation, and system functionality based on ratings from university lecturers and teachers; (4) a practicality questionnaire analyzed using a kappa statistic to assess ease of use from teachers' and students' perspectives; and (5) an effectiveness questionnaire analyzed using G-Score to assess reported improvements in the school bus selection process relative to the previous manual procedure.

The non-test instruments—the expert validation sheet, practicality questionnaire, and effectiveness questionnaire—were designed around rating scales corresponding to the indicators used in each evaluation procedure before data collection began.

2.6. Data Collection Procedure

Data were collected through the following stages:

(1) Observation and interviews concerning the existing school bus user selection process to identify system needs and decision criteria; (2) collection of the approved criteria and subcriteria as a basis for AHP pairwise comparisons; (3) development of a system prototype from the requirements analysis and design; (4) distribution of expert validation forms to computing lecturers and teachers to assess system suitability before user testing; (5) distribution of practicality and effectiveness questionnaires to teachers and students following direct use of the system; and (6) compilation and tabulation of the collected responses for analysis using the stated methods.

2.7. Product Testing

Product testing was intended to determine whether the system performed its required functions and to assess its reported validity, practicality, and effectiveness. Black-box testing was used to evaluate application functionality without examining the underlying code or internal structure [36]. The test plan covered core functions, including authentication (login and logout), managing criteria, subcriteria, and alternatives, entering pairwise-comparison matrices, performing AHP calculations, and exporting recommendation reports as PDF files. The product evaluation also included the validity, practicality, and effectiveness assessments described in the Instruments and Data Analysis sections.

2.8. Data Analysis

The collected data were analyzed as follows:

(1) AHP analysis: normalizing pairwise-comparison matrices, deriving criterion and subcriterion priority weights (eigenvectors), and calculating the Consistency Ratio (CR), as outlined in the AHP Decision Model section; (2) validity analysis: calculating Aiken's V from the ratings of computing lecturers and teachers and interpreting the values according to the specified categories; (3) practicality analysis: calculating a kappa statistic from teacher and student ratings and interpreting results across

categories from low to very high; (4) effectiveness analysis: calculating G-Score from teacher and student responses and interpreting values from low to high; and (5) black-box test analysis: comparing the expected and observed outputs for each scenario and classifying the outcome as valid or invalid.

2.9. Ethical Considerations

The manuscript reports several ethical safeguards. First, research permission was obtained from the principal of SMP Negeri 10 Payakumbuh before data collection and system trials. Second, university lecturers, teachers, and students were informed of the study's aims and provided informed consent before completing the validation sheets or questionnaires. Third, students' personal and educational information, including names, addresses, and household economic circumstances, was treated as confidential and used only for the research and school bus selection. Fourth, results were reported in aggregate form without personally identifying students, to protect participant privacy.

3. Results and Discussion

3.1. Result

3.1.1. Needs Analysis

Before development began, requirements analysis was conducted to identify system and user needs. The purpose was to establish the functional and nonfunctional requirements that would guide software design and development and help align the application with users' needs [33]. The authors report conducting observations and interviews with the vice principal for facilities and infrastructure, the vice principal for curriculum, and a representative of the Payakumbuh City Transportation Office; the information was then endorsed by the principal of SMP Negeri 10 Payakumbuh. Because school bus users were still prioritized manually, the needs analysis identified a demand for a more structured and documented decision process.

The requirements analysis identified two types of users: an administrator (the vice principal for facilities and infrastructure) and students. Administrators can manage criteria, subcriteria, student alternatives and accounts, run AHP calculations, and print recommendation reports. Students can access the system to complete their assessment information and view the selection outcome. On this basis, the application was designed to recommend a student priority ranking using the criteria specified by the school.

3.1.2. AHP Criteria and Weighting

The reported prioritization criteria were residential distance, household economic circumstances, and student discipline. Each criterion was divided into subcriteria used to assess candidates. Pairwise-comparison judgments were entered through the AHP interface, and CR values were reported for the corresponding matrices. However, the outputs of approximately 3.0 in Tables 1 and 2 have not been established as normalized priority weights. Other educational AHP studies report relative weights that sum to approximately one within a matrix and assess judgment consistency [16], [19]. Before these values can be interpreted as weights, the authors need to provide the original matrices, define each subcriterion, and clarify whether the reported values are intermediate calculations or a different measure.

Tables 1 and 2 present the outputs reported by the system. Their mathematical interpretation could not be verified without the original matrices.

Table 1. Reported AHP Numerical Outputs (Priority Weight Status Unverified)

No	Criterion	Reported output (unverified)
1	Residential distance	3,0719
2	Economic status	3,0329
3	Student discipline	3,0111
	CR	0,033

Table 2. Reported Subcriterion Outputs and CR Values (Matrices Require Verification)

No	Criterion	Subcriteria	Output	CR
1	Residential distance	3	3, 0659	0,0568
2	Economic status	3	3, 0387	0,0333
3	Student discipline	3	3, 0656	0,0566

Table 1 reports values of 3.0719, 3.0329, and 3.0111, which sum to 9.1159. These figures therefore cannot be interpreted directly as a normalized priority-weight vector for three criteria. Table 2 likewise contains outputs of approximately 3.0 without naming the individual subcriteria. The reported CR values are below 0.10, but the original matrices needed to reproduce those calculations have not been provided. Conclusions about the dominant criterion, ranking stability, or decision fairness must remain provisional until the underlying calculations and variable definitions can be examined.

3.1.3. System Design

The authors report designing the database, use case diagrams, activity diagrams, class diagram, and input and output interfaces. These artifacts describe the relationships between users, data, and AHP calculations within the application. They document the software design, but do not establish that the prioritization criteria or rankings are mathematically valid [35].

3.1.3.1. Use Case Diagram

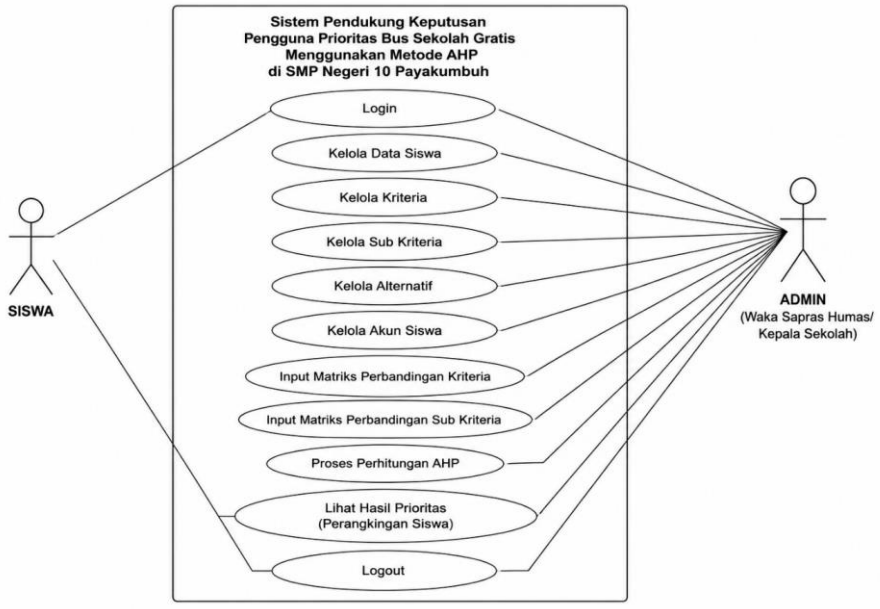


Figure 2. Use Case Diagram

The use case diagram shows interactions between the system and its two user groups: the administrator (vice principal for facilities and infrastructure) and students. Administrators can manage criteria, subcriteria, alternatives, and student accounts; assess alternatives; perform AHP calculations; view rankings; and print selection reports. Students can log in and view their selection status as prospective priority users of the school bus service. The diagram illustrates the access rights associated with each role and the intended workflow for data management and decision support.

3.1.3.2. Activity Diagram

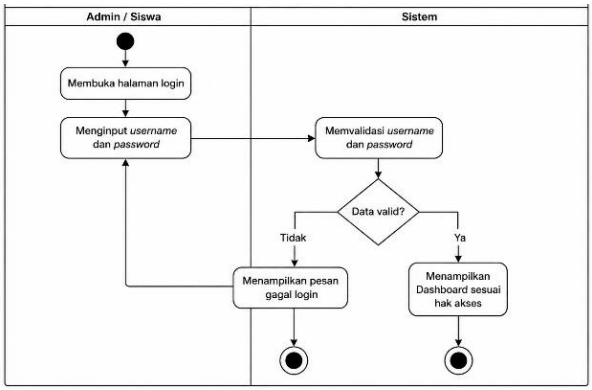


Figure 3. Activity Diagram: Login

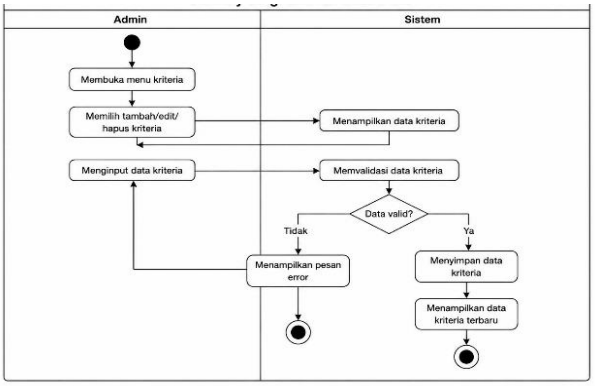


Figure 4. Activity Diagram: Manage Criteria

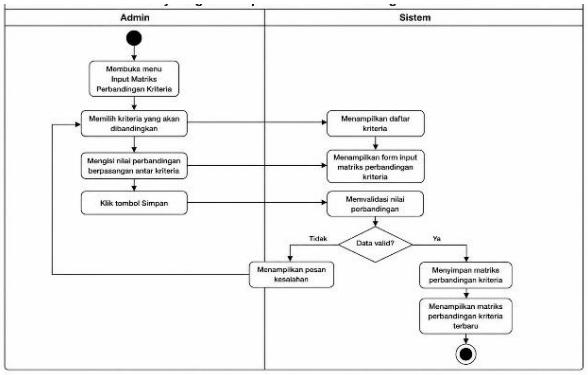


Figure 5. Activity Diagram: Enter Criterion Comparison Matrix

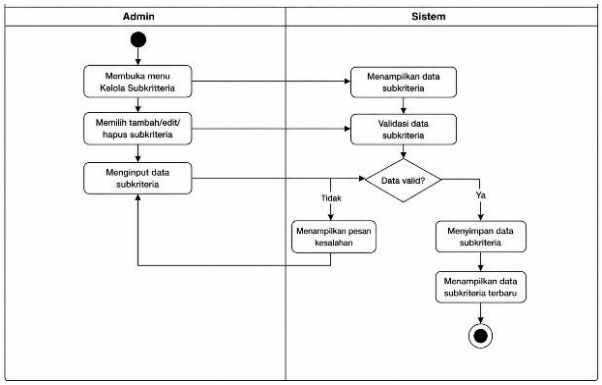


Figure 6. Activity Diagram: Manage Subcriteria

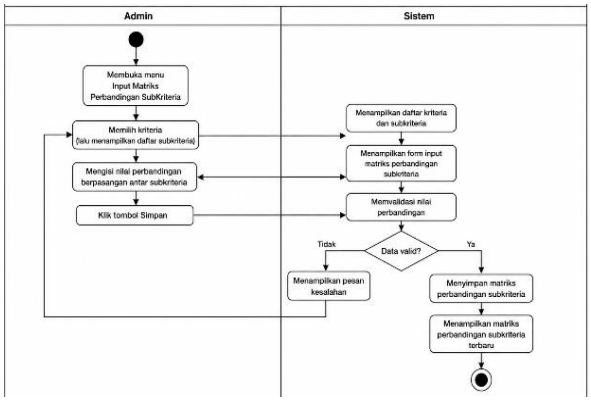


Figure 7. Activity Diagram: Enter Subcriterion Comparison Matrix

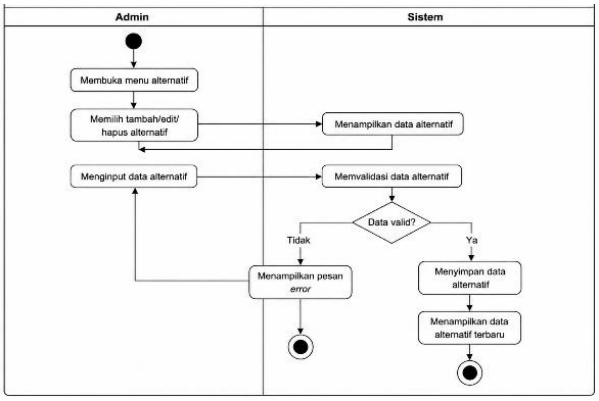


Figure 8. Activity Diagram: Manage Alternatives

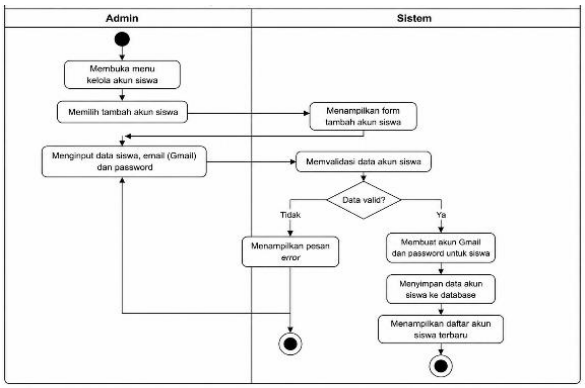


Figure 9. Activity Diagram: Manage Student Accounts

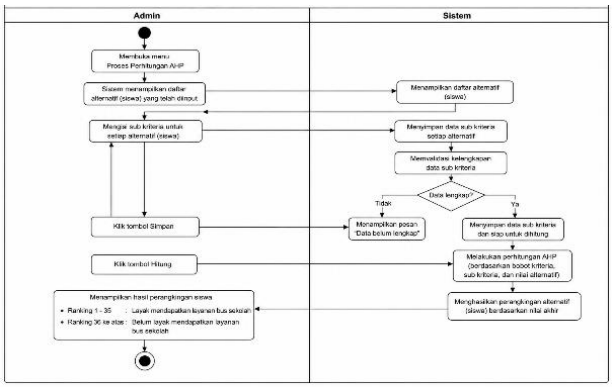


Figure 10. Activity Diagram: AHP Calculation

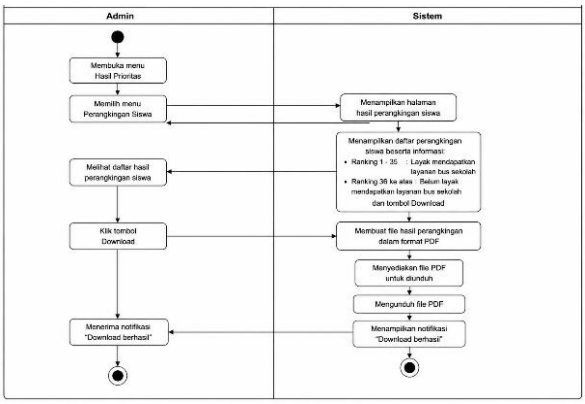


Figure 11. Activity Diagram: View Rankings and Download Results

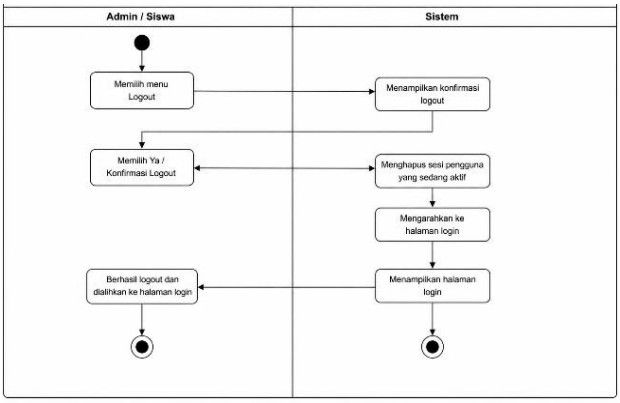


Figure 12. Activity Diagram: Logout

3.1.3.3. Class Diagram

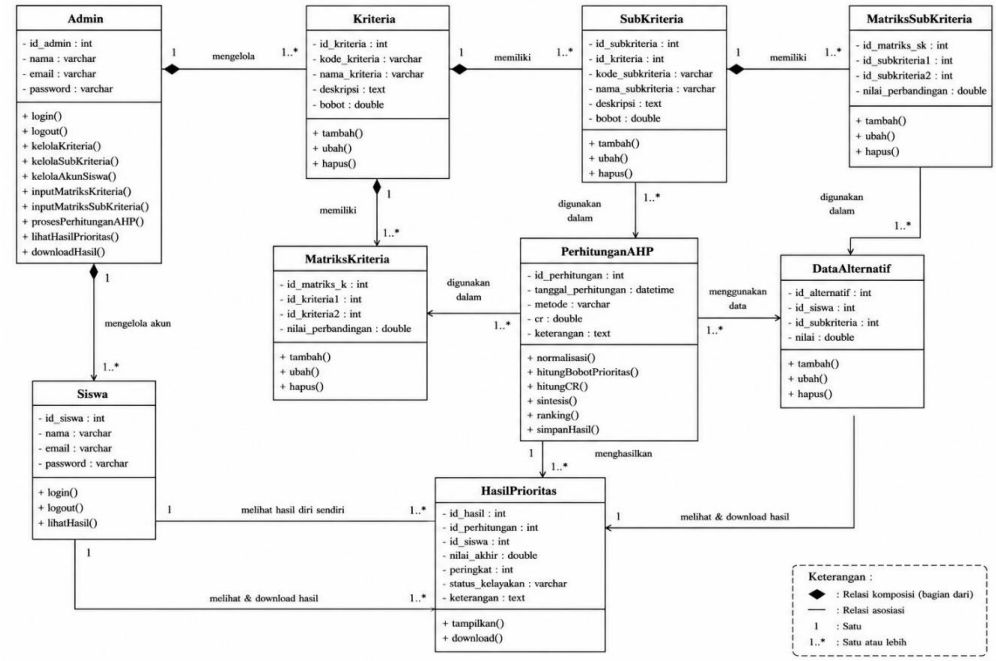


Figure 13. Class Diagram

3.1.3.4. Input Design

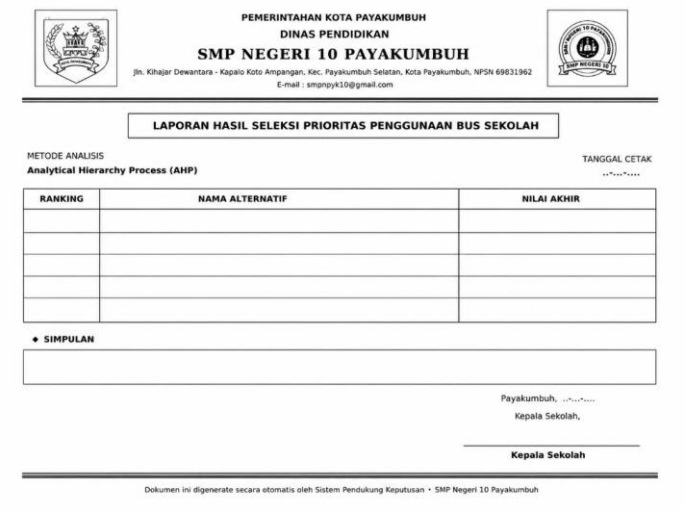


Figure 14. Input Design

The input interface allows students to enter information used in the assessment. The administrator verifies the submitted data and, once it is considered correct, selects 'Save Assessment' followed by 'Calculate'.

3.1.3.5. Output Design

The output design specifies how the application presents information after processing the data through AHP. The selection report, exported as a PDF, includes student rankings based on priority scores and their eligibility status for the school bus service. The interface is intended to present the results clearly and support school personnel in reviewing the recommendations.


PEMERINTAHAN KOTA PAYAKUMBUH
DINAS PENDIDIKAN
SMP NEGERI 10 PAYAKUMBUH
Jln. Kihajar Dewantara - Kapalo Koto Ampangan, Kec. Payakumbuh Selatan, Kota Payakumbuh, NPSN 69831962
E-mail : smpnpyk10@gmail.com

LAPORAN HASIL SELEKSI PRIORITAS PENGGUNAAN BUS SEKOLAH

METODE ANALISIS
Analytical Hierarchy Process (AHP)

TANGGAL CETAK
..-...-....

RANKING	NAMA ALTERNATIF	NILAI AKHIR

◆ SIMPULAN

Payakumbuh, ..-...-....
Kepala Sekolah,

Kepala Sekolah

Dokumen ini digenerate secara otomatis oleh Sistem Pendukung Keputusan • SMP Negeri 10 Payakumbuh

Figure 15. Output Design

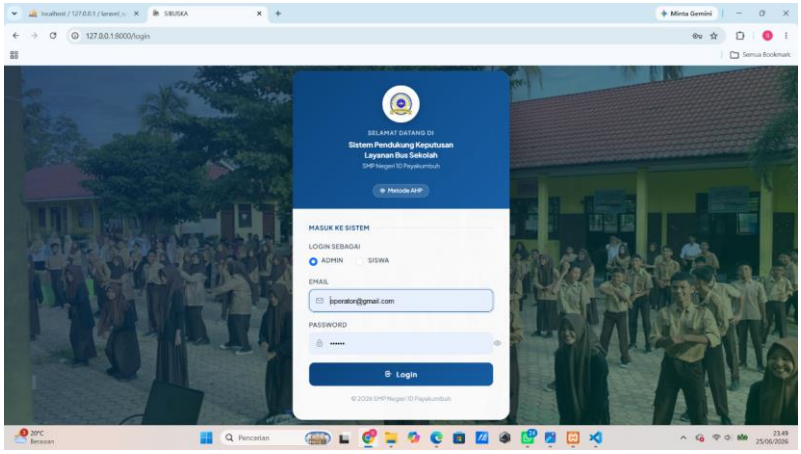
3.1.4. System Implementation

During development, the requirements analysis and design were translated into a web-based application. Software implementation involves translating system specifications into program functionality [37], [35]. The application was developed in PHP using the Laravel framework, with MySQL as the database management system. Development took place in a local environment using XAMPP as the web server.

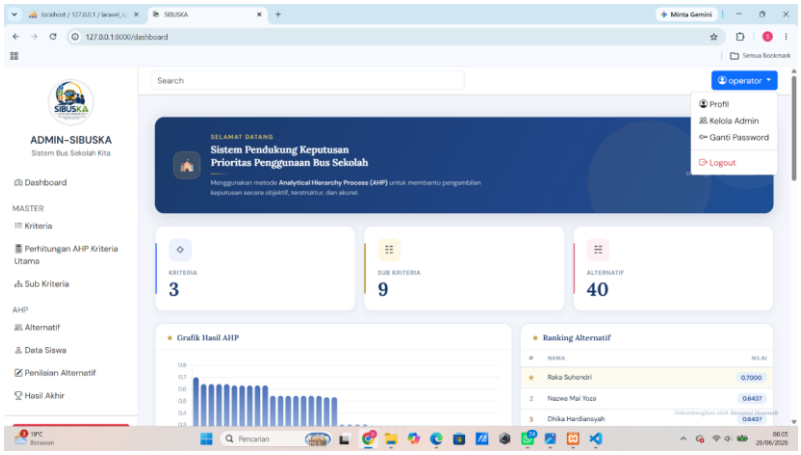
The main interface screens illustrate the implemented workflow, from data management to displaying rankings and generating reports that recommend students for priority access to the school bus service.

The principal functions of the application are described below.

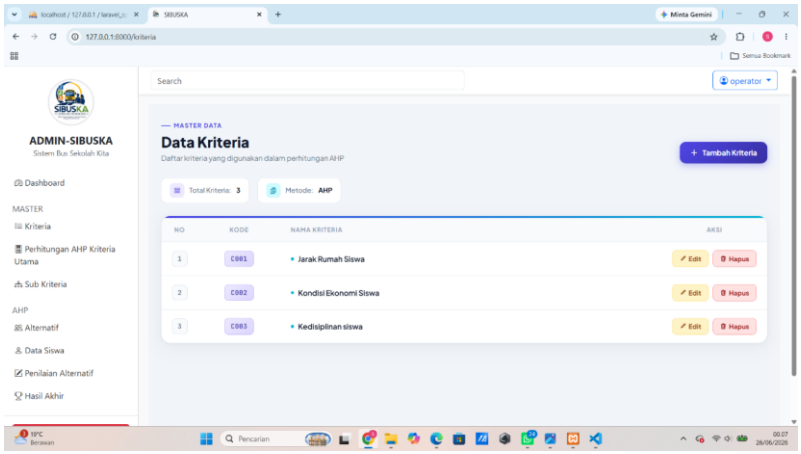
3.1.4.1. The login page is the system's initial authentication interface. Administrators and students enter their registered email addresses and passwords to access the functions available to their respective roles.



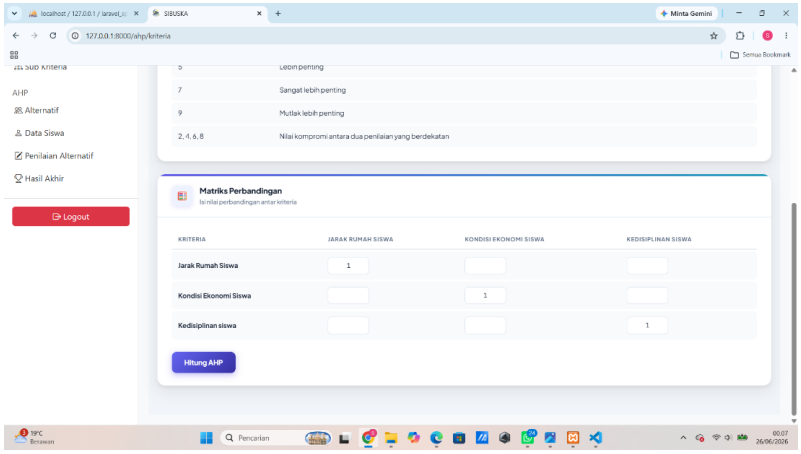
3.1.4.2. The administrator dashboard is displayed after a successful login. It summarizes system information and provides menus for managing student accounts, AHP calculations, criteria, subcriteria, alternatives, and the results of prioritizing school bus users.



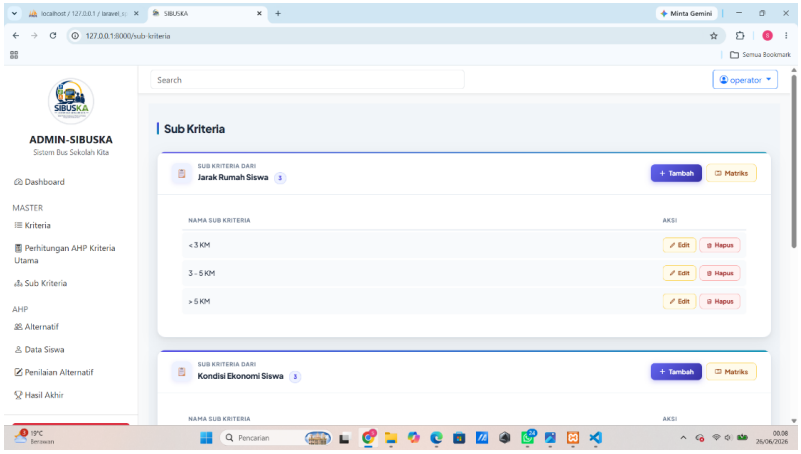
3.1.4.3. The criteria management page allows administrators to add, update, and delete the main criteria used in the decision-making process, subject to the system's access and validation rules.



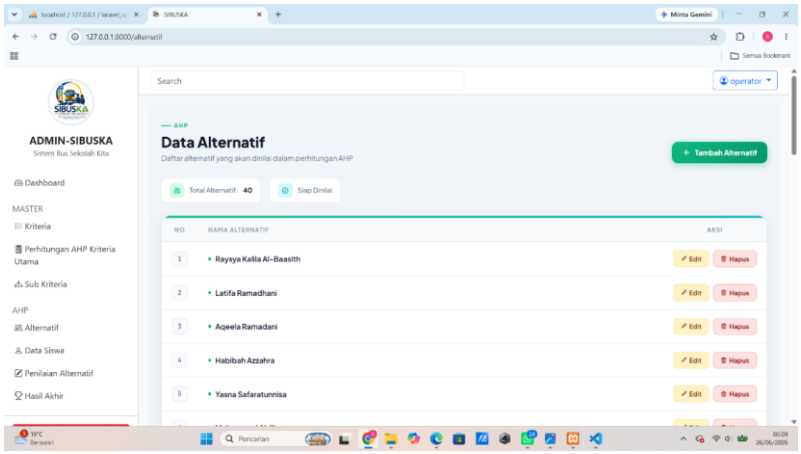
3.1.4.4. The main-criteria AHP calculation page supports pairwise comparisons of criteria. It displays Saaty's 1–9 comparison scale to guide administrators in recording the relative importance of each criterion.



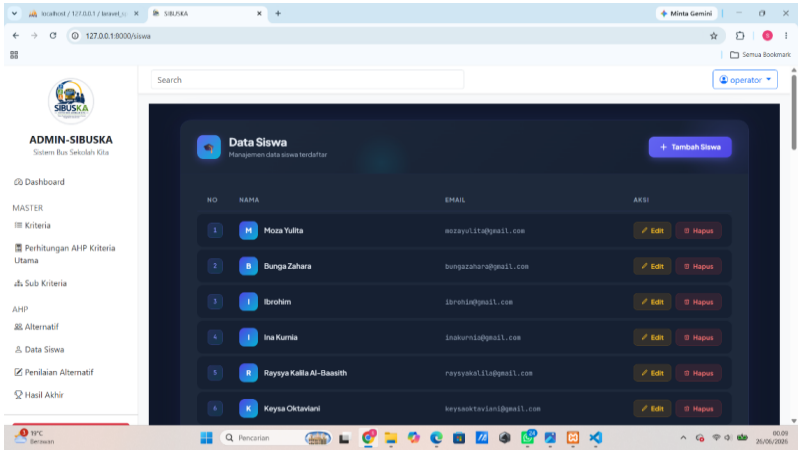
3.1.4.5. The subcriteria page stores the subcriteria associated with each main criterion. Administrators may add, edit, and delete these entries. The 'Matrix' button opens the AHP pairwise-comparison interface for the subcriteria under the selected criterion.



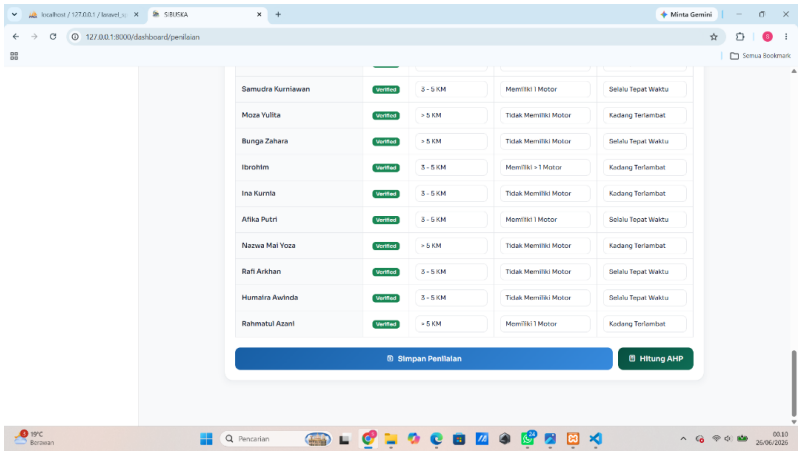
3.1.4.6. The alternatives page manages the student records considered for priority access to the school bus. Administrators can add, update, and delete these alternatives before running the AHP-based assessment.



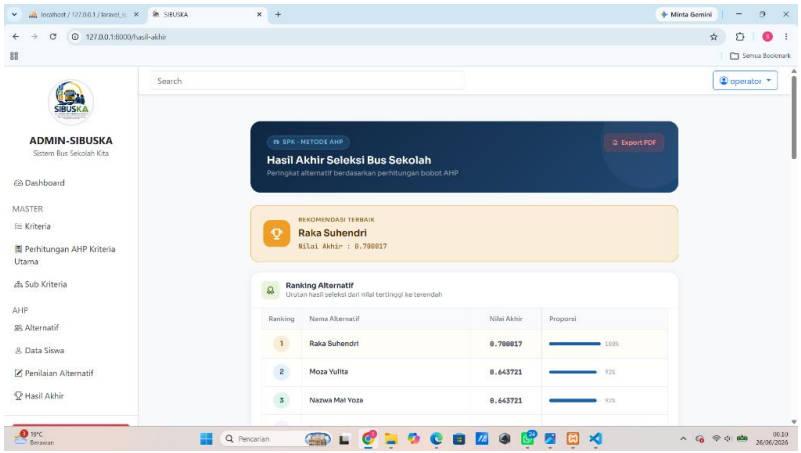
3.1.4.7. The student accounts page enables administrators to create, edit, and delete user accounts. Each student can then sign in and view the outcome of the school bus priority selection process.

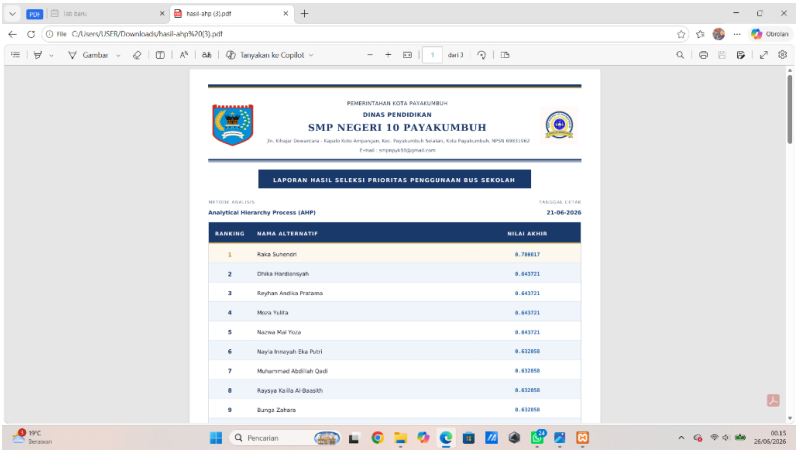


3.1.4.8. The alternatives assessment page records each student's values against the predefined subcriteria. These values are used in the reported AHP process to obtain final scores and rankings. Administrators verify the information submitted by students; once an assessment is saved, its status changes from 'pending' to 'verified'.



3.1.4.9. The final results page presents the ranking of all student alternatives based on their computed scores. It displays student names, scores, and ranks and includes a PDF export function. The resulting report contains the selection summary and a space for the principal's name, official identification number, and signature. Administrators can end their session using the logout function.





3.1.5. Functional Testing

Testing is an important stage of software development because it checks whether the application meets its requirements [38]. It can identify defects before deployment to end users [39], while appropriate test coverage helps reduce the risk of functional failures [40].

Black-box testing evaluates software functionality through inputs and expected outputs, without examining the internal program code or structure. It checks whether the observed behavior meets the specified requirements. In addition to these functional tests, the authors report separate validity, practicality, and effectiveness assessments intended to evaluate the product's suitability for use.

3.1.5.1. Black-Box Testing Results

The reported black-box tests indicate that the application's main functions operated as expected. Authentication, data management, AHP calculation, and presentation of recommendations were reported to produce the specified outputs, with no functional errors identified in the scenarios tested. The results are summarized below.

Table 3. Black-Box Testing Results

No	Scenario	Input	Expected Output	Actual Output	Status
1	Valid login	Valid credentials	Access granted	Login successful	Valid
2	View dashboard	Signed-in user	Dashboard displayed	Dashboard displayed	Valid
3	Invalid login	Invalid credentials	Login error shown	Error shown	Valid
4	Manage criteria	Add/edit/delete	Changes saved	As expected	Valid
5	Criteria matrix	Pairwise values	Values saved	Values saved	Valid
6	Manage subcriteria	Add/edit/delete	Changes saved	As expected	Valid
7	Subcriteria matrix	Pairwise values	Values saved	Values saved	Valid
8	Manage alternatives	Add/edit/delete students	Changes saved	As expected	Valid
9	Student accounts	Add/edit/delete accounts	Changes saved	As expected	Valid
10	AHP calculation	Select Calculate	Ranking shown	Ranking shown	Valid
11	Download PDF report	Select Download	PDF downloaded	PDF downloaded	Valid
12	Logout	Select Logout	Login page shown	Login page shown	Valid

3.1.6. Product Evaluation

The reported product evaluation included 12 black-box test scenarios; content-validity ratings from two university experts and two teachers analyzed using Aiken's V (0.889); practicality ratings from one teacher and ten students analyzed using a kappa statistic (0.974); and an assessment termed effectiveness using G-Score responses from one teacher and 36 students (0.935). These scores are retained as reported, although the response matrices, instrument items, calculations, and comparison

data were not included. Research on instrument development emphasizes that Aiken's V provides evidence of content validity based on expert judgments, not a substitute for validating the decisions produced by a system [41], [42]. Evaluating software usability and quality in use is also distinct from testing algorithmic outputs or operational impacts [43], [44]. The G-Score alone therefore cannot establish that student selection became faster or that transportation was allocated more equitably.

Table 4. Summary of Product Evaluation Results

Aspect	Instrument	Respondents	Mean value	Category
Validity	Aiken's V	2 computing lecturers; 2 teachers	0,889	Valid
Practicality	Kappa statistic	1 teacher; 10 students	0,974	Very high
Effectiveness	G-Score	1 teacher; 36 students	0,935	High

3.1.7. System Maintenance

The maintenance stage begins after system deployment and involves regular checks and corrective actions to sustain proper operation. Tasks include fixing defects identified after implementation, updating features, and adjusting the software to changing user needs or technology. Ongoing monitoring is also intended to support preventive maintenance [45]. Through this process, the application may continue to be improved to meet the needs of SMP Negeri 10 Payakumbuh.

3.2. Discussion

All 12 black-box scenarios in Table 3 were reported as valid. The direct conclusion supported by these tests is that the functions evaluated produced the expected outputs under those test conditions. The reported Aiken's V of 0.889, kappa of 0.974, and G-Score of 0.935 came from different instruments and respondent groups; they cannot be combined into a single measure of system effectiveness. Software quality assessment must distinguish functional suitability, instrument content validity, user experience, and operational impacts [43], [44]. Neither anonymized rankings nor independently reproducible matrix calculations have been provided.

AHP offers a framework for translating stakeholder judgments into numerical priorities, but this structure does not ensure that the initial criteria are free from bias. Residential distance and economic circumstances may reflect transportation need, whereas student discipline may shift the emphasis from need toward behavioral compliance. Mobility equity research suggests that barriers experienced by vulnerable groups are not always captured by a single indicator [3], [4], [46]. The present study has not reported a fairness audit, weight stability analysis, or verification of the original matrices. Its demonstrated contribution is therefore a more explicit decision-making workflow, rather than evidence of more equitable allocation.

This study differs from earlier school transportation research in its primary focus. Previous studies examined relationships between transportation access and attendance, whereas this study developed a prototype for ranking prospective users at one school [1], [2], [5]. Bus routing optimization addresses another problem: bus stop locations, scheduling, and vehicle movements [25]. These comparisons establish the relevance of the research problem, but do not demonstrate that the present algorithm or selection policy is superior.

AHP studies on exemplary student selection, financial assistance, and academic pathway choice demonstrate that ranking outcomes depend on the selected criteria and their weights [15], [17], [18], [19], [20]. The present application uses different criteria because it concerns free school bus services, but it has not compared the recommendations with manual decisions or alternative multicriteria methods. AHP literature also notes the possibility of rank reversal when alternatives change and of uncertainty in stakeholder judgments [28], [30]. The findings should therefore be presented as system development and preliminary evaluation, not as conclusive verification of ranking objectivity.

The application provides student data management, criterion comparisons, AHP calculations, and PDF report downloads. These functions may improve the documentation and traceability of decisions. However, no before-and-after selection-time measurements or allocation quality audit were provided to establish gains in efficiency or substantive transparency. Before routine use, the school should also establish rules for recipient selection, data corrections, and appeals [6], [27].

The study was limited to one school, purposively selected participants, and criterion weights assigned by a small group of raters. The original AHP matrices, anonymized ranking calculations, and source data for Aiken's V, kappa, and G-Score were unavailable. Selection time, equitable access, attendance, and learning outcomes were not directly measured. Because the application processes students' names, addresses, and household financial information, data safeguards, consent records, and permission to reproduce interface screenshots require verification. Findings from this setting cannot be generalized to other school transportation policies.

Future work should document the original matrices, normalized weights, anonymized rankings, and sensitivity analyses; examine whether discipline is an ethically defensible criterion; compare recommendations with expert judgments and students' needs; and measure selection time before and after deployment. Multischool evaluations and comparisons with other multicriteria methods are also warranted, while accounting for assessment limits and educational service goals [29], [30].

4. Conclusion

This study developed a web-based AHP prototype to prioritize prospective users of free school bus services at SMP Negeri 10 Payakumbuh. Using residential distance, household economic circumstances, and discipline as locally defined criteria, the system manages student data and exports rankings as PDF reports. All 12 reported black-box scenarios passed; product scores were Aiken's V = 0.889, kappa = 0.974, and G-Score = 0.935. These scores do not establish faster selection, fairer allocation, or improved educational outcomes. The AHP outputs in Tables 1 and 2 remain unverified because the original matrices and anonymized rankings were unavailable. The contribution is an initial, documented decision-support workflow; mathematical validity, recommendation accuracy, student data safeguards, and operational impacts require assessment before wider deployment.

Acknowledgments

The authors thank SMPN 10 Payakumbuh and those who supported the study. Information that could identify the authors has been withheld from this double-anonymous review copy.

Declarations

Author Contribution Statement

Saniatul Hasanah contributed to the study's conceptualization and design, data collection and analysis, system development, and preparation of the original manuscript. Liza Efriyanti contributed to supervision, methodological review, critical revision of the manuscript, and approval of its final version, consistent with the submitted authorship declaration.

Funding Statement

The authors reported receiving no dedicated external funding; the research was self-funded.

Data Availability Statement

The study data and school records are not publicly available because they contain confidential student and institutional information. Requests for appropriately de-identified supporting materials may be directed to the corresponding author, subject to school authorization and applicable privacy requirements. Complete instrument records needed to verify every reported index were not included in the submitted manuscript.

Declaration of Interests Statement

The authors declared no relevant financial or nonfinancial conflicts of interest.

AI Use Statement

GPT-6 (OpenAI) assisted with post-review editing and restructuring of the manuscript, literature searching and synthesis, and language refinement. This assistance was not used to generate field data or statistical results. The authors remain responsible for verifying sources, numerical results, and scientific statements and for approving the version submitted to the journal.

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