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AHP-based Selection of Outstanding Students

Dian Retno Utami
Universitas Indo Global Mandiri, Palembang, Indonesia

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Corresponding Author:

Dian Retno Utami
Universitas Indo Global Mandiri, Indonesia
Email: dian_uigm@gmail.com

Abstract

The decision support system employs the Analytical Hierarchy Process (AHP) method to enhance the selection of outstanding students at SMA Muhammadiyah 8 Palembang. This system acknowledges the limitations of the current evaluation process, which relies solely on academic scores and aims to rectify this by integrating additional factors like attendance, behavior, and non-academic achievements. The AHP method's systematic breakdown of criteria and sub-criteria, supported by figures and tables, elucidates the decision-making process, ensuring a more comprehensive evaluation framework. The development of this system follows the Waterfall model, emphasizing sequential phases from analysis to implementation, yet acknowledging its challenges in accommodating evolving requirements. The method section expounds on the AHP process, delineating its steps in structuring problems, conducting pairwise comparisons, creating priority matrices, and arriving at conclusive decisions. It also outlines the hierarchical model and the subsequent ranking of alternatives, showcasing how the AHP method facilitates a fairer assessment of outstanding students. The conclusion underscores the system's functionality, validated through Black Box testing, affirming its alignment with initial expectations. Overall, this comprehensive approach advocates for a more holistic method of identifying outstanding students.

Keywords: *Analytical Hierarchy Process (AHP), Evaluation Framework, Comprehensive Assessment*

Abstrak

Sistem pendukung keputusan ini menggunakan metode Analytical Hierarchy Process (AHP) untuk menyempurnakan seleksi siswa berprestasi di SMA Muhammadiyah 8 Palembang. Sistem ini menjadi solusi keterbatasan proses evaluasi saat ini, yang hanya mengandalkan nilai akademik dan bertujuan untuk memperbaikinya dengan mengintegrasikan faktor-faktor tambahan seperti kehadiran, perilaku, dan prestasi non-akademik. Perincian kriteria dan sub-kriteria secara sistematis dalam metode AHP, didukung oleh gambar dan tabel, menjelaskan proses pengambilan keputusan, memastikan kerangka evaluasi yang lebih komprehensif. Pengembangan sistem ini mengikuti model Air Terjun, yang menekankan fase berurutan mulai dari analisis hingga implementasi, namun juga mengakui tantangannya dalam mengakomodasi kebutuhan yang terus berkembang. Kesimpulannya menggarisbawahi fungsionalitas sistem, divalidasi melalui pengujian Black Box, menegaskan keselarasan dengan ekspektasi awal. Secara keseluruhan, pendekatan komprehensif ini menganjurkan metode yang lebih holistik dalam mengidentifikasi siswa berprestasi.

Kata kunci: Analytical Hierarchy Process (AHP), Evaluation Framework, Comprehensive Assessment

1. INTRODUCTION

Education is the first step to forming good character and an effort to produce a superior generation of the nation. In the field of education, outstanding students have an important role for the nation and the opportunity to have a good future is open large. With the presence of outstanding students, it is hoped that we can give birth to a generation of people with character, a competitive spirit, a spirit of nationalism and integrity so that they can continue the leadership of the nation. SMA Muhammadiyah 8 Palembang is a private high school located on Jalan TPH Sopyan Kenawas, Gandus District in Palembang City. So far, the selection of outstanding students at SMA Muhammadiyah 8 Palembang has been based on the highest report card scores. Student attendance, behavior, and non-academic achievements have not been taken into consideration in determining outstanding students, so the results of this decision are considered unfair to other students who meet the standards.

Based on this background, the author proposes a decision support system using the AHP method in determining outstanding students. The Analytical Hierarchy Process (AHP) method is a decision-making process using pairwise comparisons to explain evaluation factors and weight factors in multi-factor conditions [1], [2]. The system development method that the author uses is the Waterfall method accompanied by UML (Unified Modeling Language) as a tool of system design. Meanwhile, the database implementation uses MySQL. The input design includes user login, alternative data input, criteria input, AHP basic scale input, initial value input, AHP basic scale input, criteria analysis input, alternative analysis input, and user input. The output design is in the form of alternative data list output, criteria list output, AHP basic scale list output, initial value output, criteria comparison output, alternative output according to criteria, report output, and user data output.

2. METHOD

Figure 1 illustrates the research methodology employed by the author to fulfill the initial objectives. The system development phase utilized in this study is the waterfall model, known for its characteristic requiring completion of each phase before advancing to the subsequent one. This approach follows a structured and linear flow within software development [3], [4], [5]. The process comprises a sequence of phases that must be finished in order, where the conclusion of each phase is reliant on the prior one. Below are several primary stages within the Waterfall model:

1. Analysis: The stage where system requirements are gathered and thoroughly understood. It involves interaction with users and stakeholders to define functional and non-functional requirements.
2. Design: After the requirements are collected, the next step is to design the system architecture. This includes designing the system structure, identifying algorithms, and preparing the necessary technical specifications.
3. Coding: This stage involves coding the software according to the specifications created at the design stage. The development team creates code based on the approved design.
4. Testing: After implementation, the system is tested to ensure that all requirements have been met and that there are no significant bugs or errors. These tests include functional, performance, and security tests.
5. Delivery/Implementation: Once the system passes all the tests, it is ready to be implemented and released into a production environment or used by end users.

A significant drawback of the Waterfall model is its challenge in accommodating frequent alterations in software development requirements. Its linear structure makes it hard to revisit a prior phase once it's completed, posing difficulties in adapting to evolving needs during the cycle.

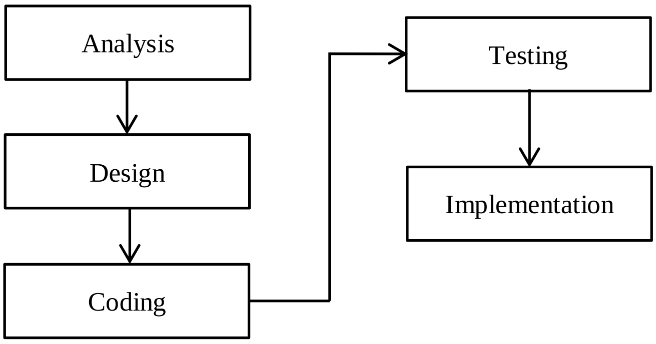


Figure 1 – Simple system development model

The Analytical Hierarchy Process (AHP) is a decision-making framework developed by Thomas Saaty that helps in systematically breaking down complex problems into smaller, more manageable parts, and then evaluating and comparing those parts to make informed decisions. It's particularly useful when faced with multi-criteria decision-making problems. AHP involves several steps:

a. Structuring the problem: Identify the main goal or objective and break it down into smaller, hierarchically arranged criteria and sub-criteria. For instance, if you're deciding on the best location for a new office, criteria might include cost, accessibility, and available amenities.
b. Pairwise comparisons: Compare each criterion or sub-criterion with every other criterion or sub-criterion in terms of their relative importance using a scale. The scale usually ranges from 1 to 9, where 1 implies equal importance and 9 indicates extreme importance. This step is iterative and involves establishing priorities between elements in the hierarchy.
c. Creating the priority matrix: Construct a matrix based on these pairwise comparisons and compute the weights or priorities for each criterion and sub-criterion. Mathematical calculations are done to derive these priorities.
d. Consistency check: Ensure that the judgments made in the pairwise comparisons are consistent. Inconsistencies can be resolved by revisiting the comparisons and making adjustments until a consistent set of priorities is achieved.
e. Aggregation and final decision: Combine the priorities obtained for each criterion to determine the overall ranking or decision. This final step integrates the weighted criteria to reach a conclusive decision.

3. RESULTS AND DISCUSSION

This decision support system uses the Analytical Hierarchy Process (AHP) method so criteria and alternatives are needed. The criteria were determined based on the results of interviews with SMA Muhammadiyah 8 Palembang. The results obtained were:

1. The decision support system at SMA Muhammadiyah 8 Palembang has criteria for academic grades, attendance, attitude grades, and non-academic grades
2. The decision support system at SMA Muhammadiyah 8 Palembang has alternatives to Student1, Student2, Student3, and Student4.

The criteria and alternative data can be created into a hierarchical model for selecting outstanding students at SMA Muhammadiyah 8 Palembang as shown in Figure 2.

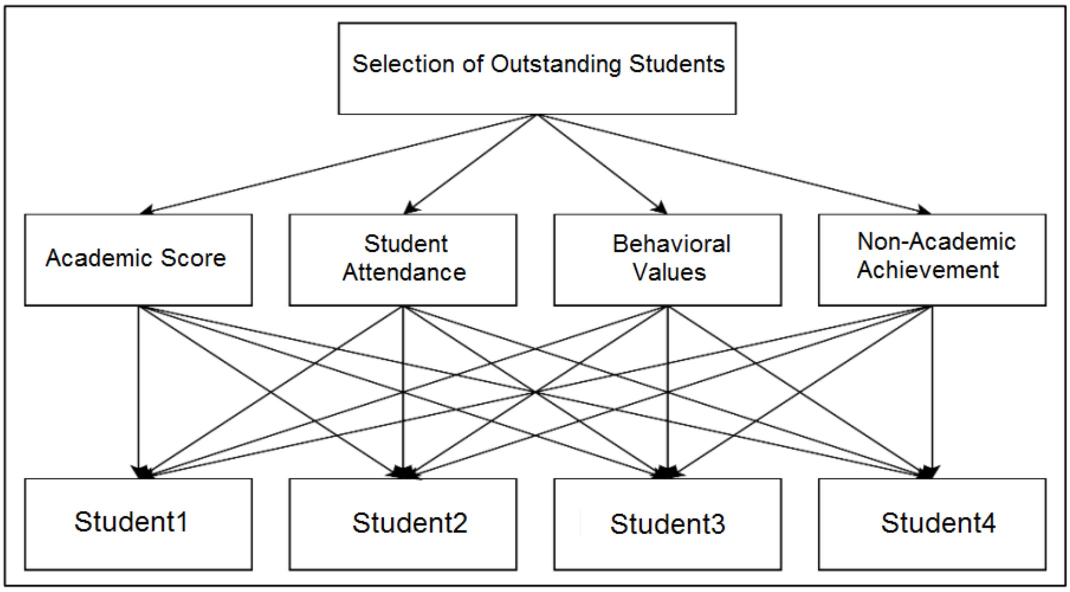


Figure 2 – Hierarchical Model for Selection of Outstanding Students

To achieve the goals explained in the hierarchical model, a decision support system calculation will be carried out. In the results of this calculation, the researcher conducted interviews with the deputy head of curriculum to obtain a priority scale (level of importance) or basic scale for pairwise comparisons. In this calculation, there are 4 criteria with 4 alternatives. Priority scale assessment data against the criteria is shown in Table 1.

Table 1 – Hierarchical Matrix For Criteria

No	Criteria	Academic Score	Student Attendance	Behavioral Values	Non-Academic Achievement
1	Academic Score	1	3	5	7
2	Student Attendance	1/3	1	4	5
3	Behavioral Values	1/5	1/4	1	2
4	Non-Academic Achievement	1/7	1/5	1/2	1

Table 1 shows that academic score criteria are 3 times more important than student attendance, academic score criteria are 5 times more important than behavior scores, academic score criteria are 7 times more important than non-academic achievements, attendance criteria are 4 times more important than behavior scores, criteria attendance is 5 times more important than non-academic achievement, behavioral value criteria are 2 times more important than non-academic achievement. The author doesn't cover all the stages, so go straight to the end. The ranking process will be carried out when all criteria analysis and alternatives have been carried out where the value of the ranking data is obtained from the average calculation results for each criterion multiplied by the average number of alternatives from the comparison analysis of the criteria. The comparative data between alternatives and criteria is shown in Table 2.

Table 2 – Calculation of Ranking Data

Alternatives	Criteria				Result
	Academic Score	Student Attendance	Behavioral Values	Non-Academic Achievement	
Student3	0.3100	0.1590	0.0565	0.0314	0.5596
Student4	0.1403	0.0719	0.0255	0.0154	0.2531
Student1	0.0702	0.0371	0.0132	0.0080	0.1285
Student2	0.0328	0.0165	0.0059	0.0035	0.0587

Table 2 shows that the Student3 alternative is the best result based on the decision support system for selecting outstanding students using the AHP method with a score of 0.5596. The ranking results after sorting can be seen in Table 3.

Table 3 – Ranking Results

Order	Class	Alternatives	Final Results
Best 1	Science Class 10	Student3	0.5596
Best 2	Science Class 10	Student4	0.2531
Best 3	Social Class 10	Student1	0.1285
Best 4	Social Class 10	Student2	0.0587

After understanding how the decision support system selecting outstanding students using the AHP method, the author started designing the proposed app by creating a UML diagram [6], [7]. The proposed system design includes Use case diagrams, Activity diagrams, Sequence diagrams, and Class diagrams.

3.1. Use Case diagram

Several things need to be described, namely actors and use cases. Actors are users who are connected to the system and can be people (indicated by their role and not their name/personnel). The actor is symbolized by the figure of a stick man with a noun at the bottom that states the role/system. Use cases are depicted with an ellipse symbol with the name of the active verb inside which states the activity from the actor's perspective [8], [9].

3.2. Activity diagram

An activity diagram is a description of function paths in an information system [10]. In full, the activity diagram defines where the system process starts, where it stops, what activities occur during the system process, and what sequence these activities occur in.

3.3. Class diagram

Class diagrams describe the types of objects in the system and the various static relationships that exist between them [11]. Class diagrams show the properties and operations of a class and the boundaries contained in the object relationships. Figure 3 shows the class diagram of the proposed system.

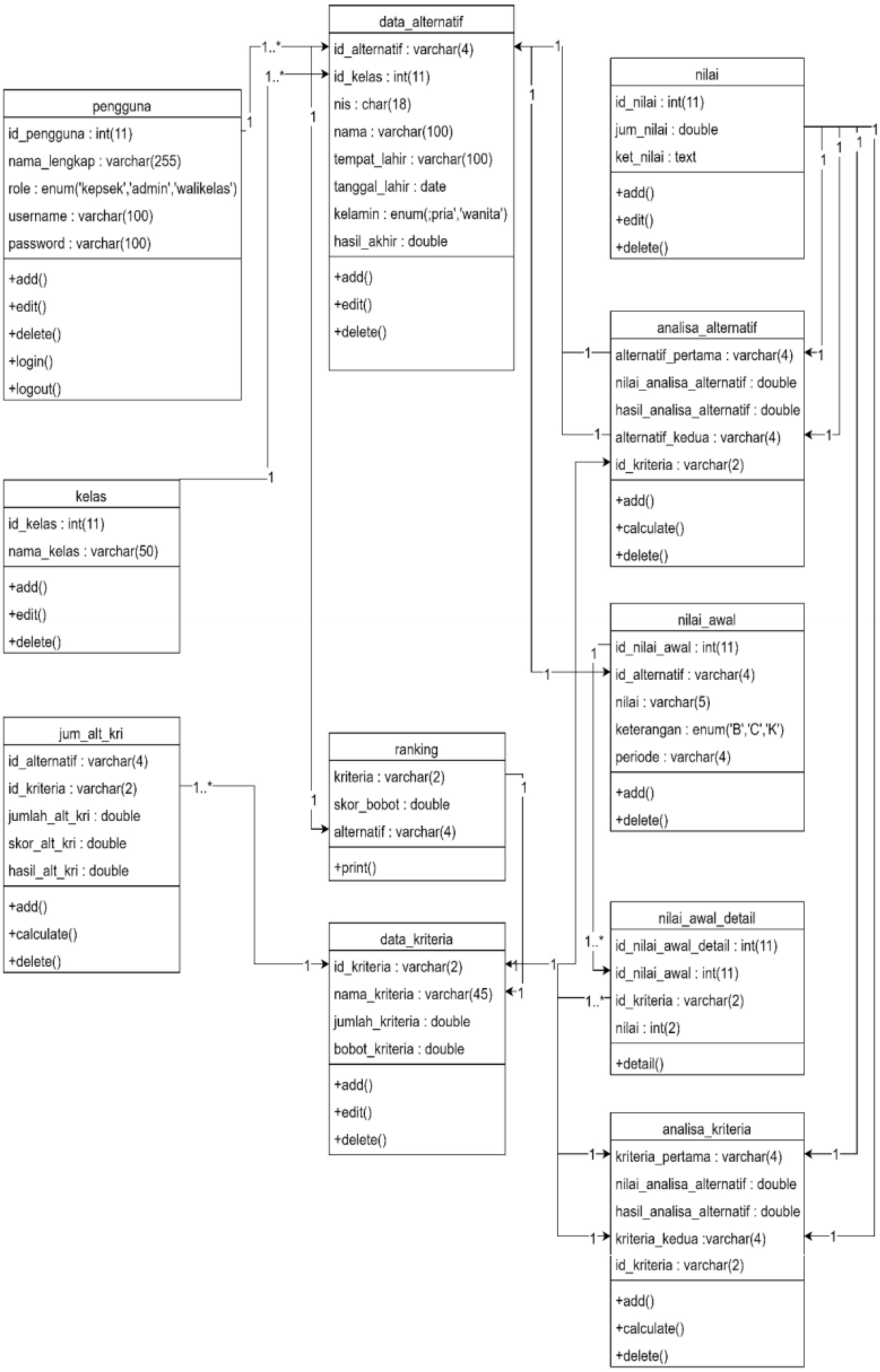
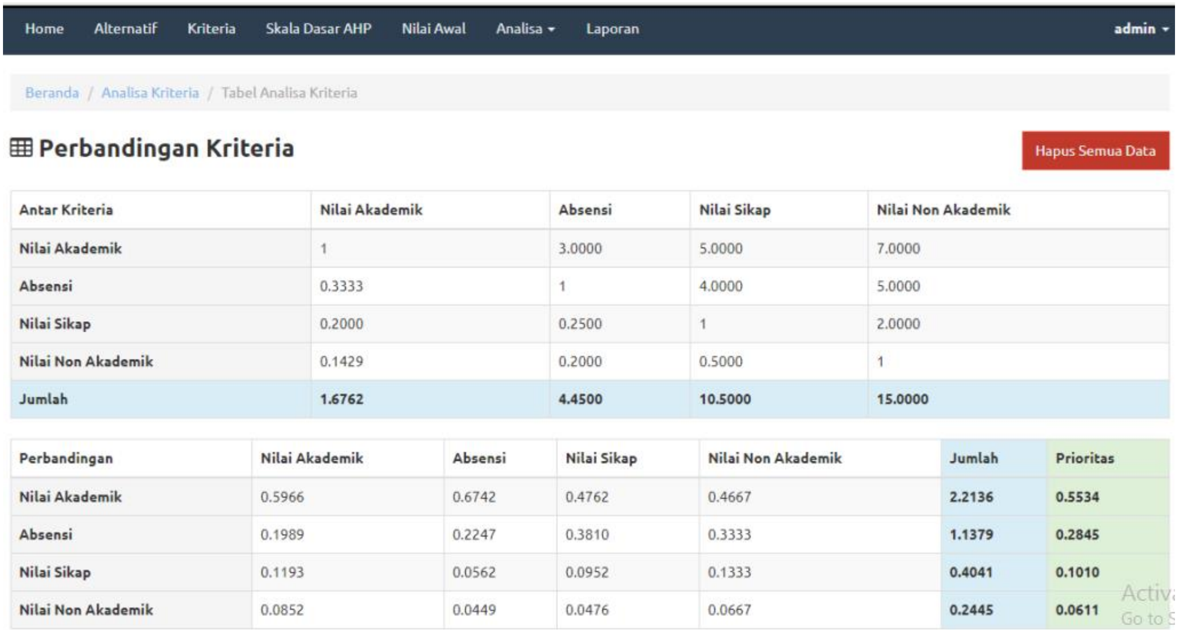


Figure 3 – Class Diagram

3.4. System Interface

A system interface refers to the point of interaction or communication between different systems, components, or software modules within a larger system or between separate systems. It defines how different parts of a system communicate, exchange data, or interact with each other. One example of the interface of the proposed system is the criteria comparison analysis page (Figure 4).



Antar Kriteria	Nilai Akademik	Absensi	Nilai Sikap	Nilai Non Akademik
Nilai Akademik	1	3.0000	5.0000	7.0000
Absensi	0.3333	1	4.0000	5.0000
Nilai Sikap	0.2000	0.2500	1	2.0000
Nilai Non Akademik	0.1429	0.2000	0.5000	1
Jumlah	1.6762	4.4500	10.5000	15.0000

Perbandingan	Nilai Akademik	Absensi	Nilai Sikap	Nilai Non Akademik	Jumlah	Prioritas
Nilai Akademik	0.5966	0.6742	0.4762	0.4667	2.2136	0.5534
Absensi	0.1989	0.2247	0.3810	0.3333	1.1379	0.2845
Nilai Sikap	0.1193	0.0562	0.0952	0.1333	0.4041	0.1010
Nilai Non Akademik	0.0852	0.0449	0.0476	0.0667	0.2445	0.0611

Figure 4 – The Interface of Criteria Comparative Analysis

Figure 3 shows the results of the AHP method decision support system calculations. There are two tables, the first table is a table of 80 simplified results of the comparison of criteria that the admin entered during the previous criteria analysis by providing values between the criteria. To get results from a simple table, you need to add up each criteria analysis result that the admin has previously input. Next, the second table shows the results of a calculation called a normalization table, which is obtained in the following way: 1. Divide each value from the simplified table column by the total of the simplified value column. 2. Add up the values from each row and divide them by the number of elements to get the weight value also often called the average value.

In the end, the author carries out Black Box testing of the app that has been built. Black Box testing focuses on the functional requirements of the software [12]-[15]. Thus, black box testing allows software engineers to obtain a set of input conditions that fully utilize all functional requirements for an app. Black box testing seeks to find errors in the following criteria: Incorrect or missing functions, Interface errors, Errors in data structure or database access, and Performance errors. Based on the test results, overall the app built meets all testing criteria, in line with expectations at the start of the study.

4. CONCLUSION

The proposed decision support system employing the Analytical Hierarchy Process (AHP) method at SMA Muhammadiyah 8 Palembang presents a structured approach to rectify the current method of selecting outstanding students. By incorporating academic grades, attendance, attitude grades, and non-academic achievements, this system aims for a more comprehensive evaluation process. The systematic breakdown using the AHP method, illustrated through tables and matrices, facilitates a clear understanding of the decision-making process. The system's development, following the Waterfall model, highlights the importance of sequential phases from analysis to implementation, though it acknowledges the model's limitations in adapting to evolving requirements. The discussion encompasses various aspects, from the hierarchical model to the calculations determining the best-performing student through the AHP method. The inclusion of UML diagrams further enhances comprehension by visually representing the proposed system's architecture. The concluding Black Box testing confirms the system's functionality, fulfilling the outlined functional requirements and validating its alignment with the study's initial expectations. Overall, this comprehensive approach advocates for a fairer and more holistic method of recognizing outstanding students, addressing the shortcomings of the current selection process at SMA Muhammadiyah 8 Palembang.

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