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Parallel Class Ranking Model Using Analytic Hierarchy Process With Multi Criteria

Model Perangkingan Kelas Paralel Menggunakan Analitic Hierarchy Process dengan Multi Kriteria

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Abstract—Madrasah Aliyah Negeri (MAN) Banyuwangi using a worksheet which can lead to error occurrences and slow decision making. A system for decision support that can improve the ranking process and quality were developed in this paper. The proposed system implemented the codeigniter framework, MySQL database, and PHP programming language. The system provided three user roles which are teacher, student, and administrator role. These four parameters are used as ranking system input, including academic values, non-academic values, violation scores, and student attendance. The ranking process was conducted by applying the analytic hierarchy process (AHP) method. The developed decision support system was tested using two ways: the black box testing method and providing questionnaires. Black box testing result shows that the system has functionally worked, while user's questionnaire gives 92,29% well accepted by users. The results show that the decision support system can help manage values and determine the parallel ranking list.

Keywords— parallel ranking, analytic hierarchy process, MAN Banyuwangi

Abstrak—Madrasah Aliyah Negeri (MAN) Banyuwangi menggunakan pemeringkatan dengan worksheet sehingga dapat menimbulkan kesalahan dan lambatnya proses pengambilan keputusan. Dari permasalahan tersebut maka dikembangkan suatu sistem pendukung keputusan yang dapat memudahkan proses penentuan peringkat dengan cepat dan berkualitas. Sistem ini dibangun menggunakan codeigniter framework, basis data MySQL, dan bahasa pemrograman PHP. Sistem menyediakan hak akses untuk tiga jenis pengguna yakni guru, siswa, dan admin. Parameter yang digunakan sebagai dasar perangkingan yaitu nilai akademik, nilai non-akademik, skor pelanggaran, dan kehadiran siswa. Proses perangkingan selanjutnya dilakukan menggunakan metode analytic hierarchy process (AHP). Pengujian terhadap sistem yang dikembangkan menggunakan dua metode yaitu black box dan kuesioner. Hasil pengujian black box menunjukkan sistem telah berfungsi dengan baik, sedangkan hasil kuesioner memberikan nilai akhir 92,29% dapat diterima dengan baik oleh pengguna. Dari hasil tersebut dapat disimpulkan bahwa sistem pendukung keputusan ini dapat membantu pengelolaan nilai dan penentuan daftar peringkat paralel.

Kata Kunci—perangkingan paralel, analytic hierarchy process, MAN Banyuwangi



I. INTRODUCTION

Class assessments are conducted by teachers to measure the achievement and development of students' learning processes towards the achievement of learning goals and mastery of competencies [1]. The results of the assessment are then used to determine student achievement. Schools that have many study groups in the same class usually also use a parallel ranking model. At the Banyuwangi Aliyah State Madrasah (MAN), high school (SMA) level schools under the auspices of the Indonesian Ministry of Religion, value processing and parallel achievement ranking in this school still use conventional systems that use worksheets. With a total of 1,003 students and 31 classes, manual classification results in error vulnerability and a slow ranking process. The primary ranking that has been running so far also only uses academic grades for the ranking of high achieving students. Ranking by including non-academic values will provide a more comprehensive picture of the assessment results [2]. On the other hand, schools also need a system that can manage student grade data properly.

To overcome the problems that have been described, a decision support system is needed to determine computerised academic and non-academic achievements that can later produce quality decisions. The system is built using the analytic hierarchy process (AHP) approach model. AHP method can be used to help the decision-making process of complex problems that have several alternative solutions to obtain the best resolution to resolve the issue. Some users of AHP in decision support systems in education include evaluating teacher performance [3], school selection [4], [5], student career development [6], scholarship determination [7], [8], and commitment of interest and majors [9]. AHP implementation for student ranking has also been carried out [10] but only using one-class data, and Z-Score is used as methods that provide a standardised value based on the deviation value and the average of each criterion

Parallel student ranking system is built using the code igniter framework by applying the AHP method. This system is equipped with academic and non-academic value storage features as an essential feature of ranking. With this system, it is expected that the decision-making process of school academic achievement will be faster and more accurate.

II. RESEARCH METHOD

In the research conducted, a web-based application system built that provides an interface to enter grades, set parameters and processing, and to display the results of the system output in the form of student rankings. Implementation of the AHP approach used as a method for

ranking students. While developing system or software applications as a whole using the waterfall method of software development models. The waterfall method in Figure 1 shows the development of a system that is carried out sequentially step by step from requirements analysis, planning, modelling, development to system implementation [11], [12].

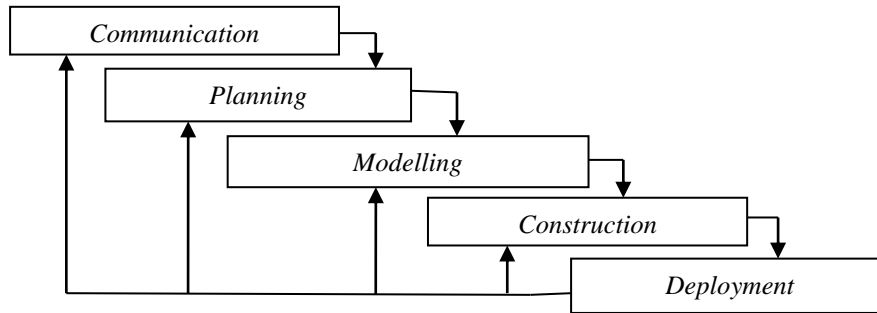


Figure 1. WATERFALL METHOD

A. Research Data

This research data collection method is done through interviews with the school and direct data collection. Interviews conducted with all parties relating to the system, including students, teachers, the administration department, and elements of school management. While direct data retrieval is done by collecting related documents and direct observation of activities related to the problem [13]. The data obtained are grouped into two parts :

1. Primary data, i.e. data used to derive the criteria used in the process of ranking the AHP method includes:

Academic Value is the value taken from the benefits of subjects in MAN Banyuwangi. The subjects can be shown in Table 1.

Table 1. SUBJECTS

Major	Subject
Religion	English, Cross-Interest Economics, Hadith Science, Al-Hadith, Interpretation, Mathematics, Indonesian Language, SKI, Kalam Science, Usul Fiqh, Cultural Arts, Health, Physical Education, Arabic Language Pmt, Entrepreneurship, Pkn, moral theology, Fiqh, Indonesian History, Morals.
Science	Mathematics, Hadith Science, Fiqh, Al Quran Hadith, Language and Literature Cross Interests, Chemistry, English, Physical Education, Physics, Indonesian Language, Moral Creed, Mathematics Pmt, Civic Education, Physics, Biology, Culture, Islamic culture history, Arabic Language.
Social	Cultural Arts, Islamic Morals, Indonesian Language, Mathematics, Economics, Cross-Interest English Literature, Sociology, English, History, Islamic culture history, Entrepreneurship, Physical Education, Quran Hadith, Geography, Indonesian History, Civic Education, Fiqh, Arabic.
Language	Entrepreneurship, Japanese Language and Literature Specialization, Physical Education, Indonesian Language and Literature, Fiqh, Indonesian History, Anthropology, English Language and Literature Specialization, Cultural Arts, Arabic Language, Indonesian Language, Aqeedah moral, Al Quran Hadith, English Language,

Non-Academic Value is the value of student self-development, which is included in achievements outside of school activities, required how active students are in participating in this activity. The extracurricular activities at MAN Banyuwangi are listed in Table 2.

Table 2. EXTRACURRICULAR

No.	Extracurricular
1	Soccer
2	Futsal
3	Scout
4	Nature lovers
5	PMR (Youth Red Cross)
6	Rohis (Rohani Islam)
7	Volleyball
8	Basketball
9	Theatre

Attendance is the amount of attendance inside and outside the class. In one semester there are 156 school days active (not including holidays). The value of violations are points of violation of the Madrasah code of conduct. The weight of violations to the order is determined based on the policies in force in Banyuwangi State Aliyah Madrasah.

2. Complementary data contained additional information related to teachers, students, classes and majors in MAN Banyuwangi, namely Religion, Sciences, Social, and Languages with 1003 students and 31 classes.

B. AHP Ranking

Flowchart for the calculation process using the AHP method is shown in Figure 2. First the admin gives the initial value of the criteria that have been determined in the form of academic, non-academic, absenteeism, and violation. After that, the admin enters data from each criterion. Then the system makes a matrix of values by comparing each of the specified criteria, then doing the eigenvector calculation. After getting the results of calculating the consistency index, then the consistency ratio. If the consistency ratio is not consistent, then repeat it from the initial determination of the weights in the criteria. If it is consistent, then calculate the results of the eigenvector criteria and eigenvector sub-criteria then produce a ranking list result.

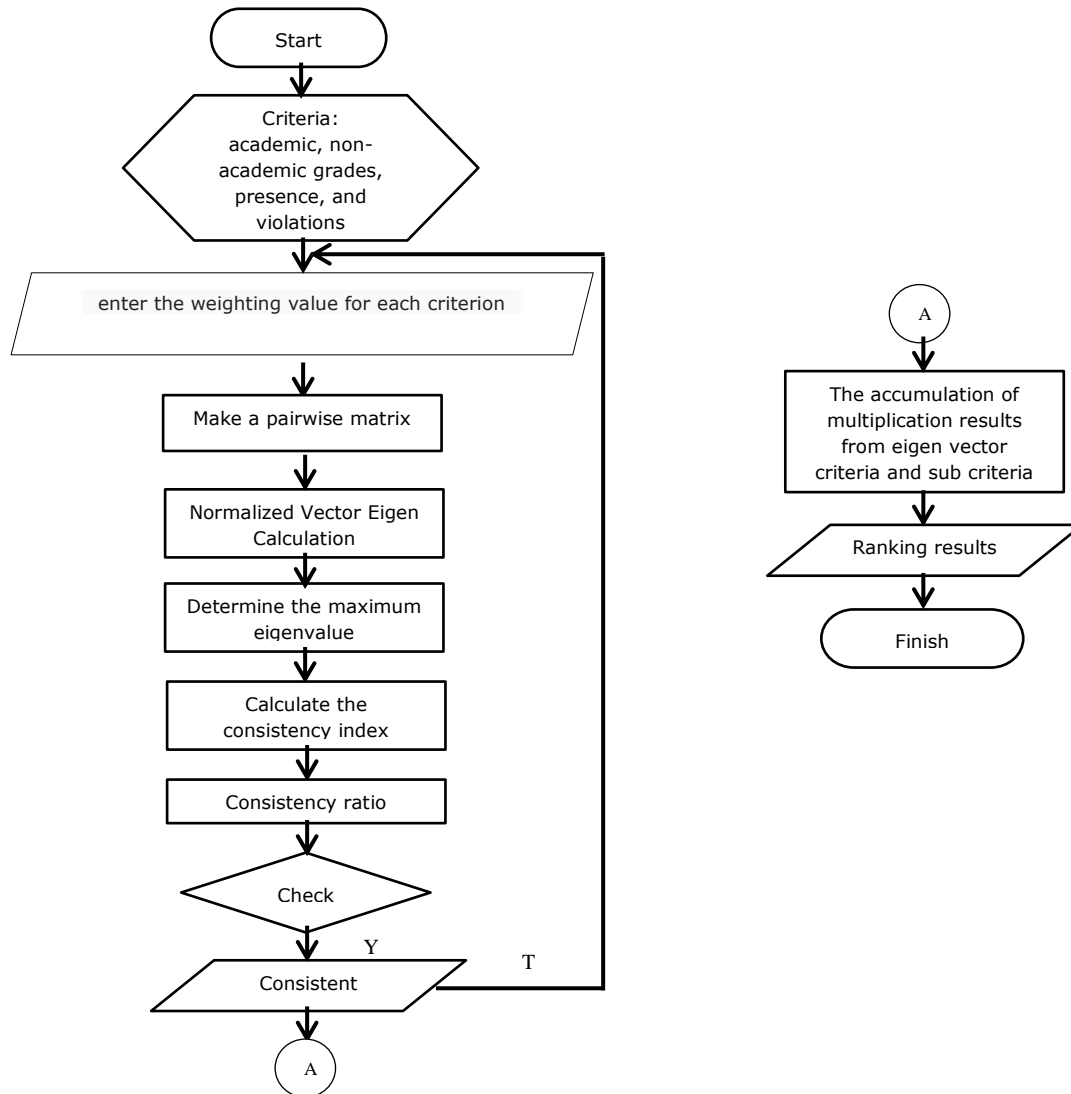


Figure 2. FLOWCHART SYSTEMS FOR LEARNING DECISIONS

Following is an example of calculation based on Figure 2 using the Analytic Hierarchy Process method according [14], [15] in parallel class ranking:

1. Establish criteria and sub-criteria and alternatives viz: Academic Value, Non-Academic Value, Attendance, and Violation.
2. Determining sub-criteria can be shown in Table 3.

3. Arrange the pairwise Comparison criteria matrix by comparing the ratings of each existing criterion. Comparative assessment of each measure is carried out by the school according to applicable regulations — Pairwise compare criteria matrix shown in Table 4.

Table 3. SUB CRITERIA

Academic Value	Very good (3499-3200), good (3299-3000), good enough (2999-2800), enough (2799-2600), bad (2599-2400).
Non-Academic Value (extracurricular achievements)	Very good (A), good (B), good enough (C), good (D), bad (E).
Attendance	Very good (144-139), good (138-133), good enough (132-127), sufficient (126-121), bad (120-115).
Violation	Very good (0), good (0-20), good enough (20-30), enough (30-50), bad (50-100)

Table 4. MATRIX OF PAIRWISE COMPARISON

	Violation	Attendance	Non-Academic	Academic
Violation	1	2	4	6
Attendance	1/2	1	3	5
Non-Academic	1/4	1/3	1	4
Academic	1/6	1/5	1/4	1

4. Change the pairwise comparison criteria matrix to decimal numbers and add up each column of criteria, as shown in Table 5.

Table 5. MATRIX OF PAIRWISE COMPARISON DESIMAL

	Violation	Attendace	Non-Academic	Academic
Violation	1	2	4	6
Attendance	0.5	1	3	5
Non-Academic	0.25	0.333	1	4
Academic	0.166	0.2	0.25	1
Total	1.916	3.533	8.25	16

5. Normalise all values by dividing each element per column by the total number of columns, as shown in Table 6.

Table 6. NORMALISED CRITERIA MATRIX

	Violation	Attendan ce	Non Academic	Academic
Violation	0.522	0.566	0.485	0.375
Attendance	0.261	0.283	0.364	0.313
Non-Academic	0.130	0.094	0.121	0.250
Academic	0.087	0.057	0.030	0.063

Table 7. CALCULATION OF EGGEN VECTOR NORMALIZATION

	Violation	Attenda nce	Non Academic	Academic	Line Total	Eigen vektor Normalization
Violation	0.522	0.566	0.485	0.375	1.946	0.486
Attendance	0.261	0.283	0.364	0.313	1.218	0.304
Non-Academic	0.130	0.094	0.121	0.250	0.595	0.148
Academic	0.087	0.057	0.030	0.063	0.234	0.058

6. Calculate normalised eigenvectors by adding up each row and dividing by the number of criteria, as shown in Table 7.

7. Calculate the consistency ratio:

- Calculate the highest eigenvalue (λ_{max})

Done by adding up the results of the multiplication values in Table 5 with the values in Table 7.

$$\lambda = (1,916 * 0.486) + (3,533 * 0.304) + (8,25 * 0.148) + (16 * 0.058) = 4.154$$

- Calculate the consistency index (CI)

$$CI = \frac{\lambda_{maks} - n}{n - 1} = \frac{4.154 - 4}{4 - 1} = 0.051$$

- Consistency ratio

RC = there are 4 criteria, the value is 0.90

$$CR = \frac{CI}{RC} = \frac{0.051}{0.90} = 0.045$$

CR < 0. 100 then the weighting preference is consistent

8. Form a Pairwise Comparison sub-criteria matrix by conducting a comparison assessment of each sub-criterion. The Pairwise Compare sub-criteria matrix is shown in Table 8.

Table 8. PAIRWISE COMPARISON SUB MATRIX CRITERIA

	Very Good	Good	Pretty Good	Enough	Bad
Very good	1	2	3	4	5
Good	½	1	2	3	4
Pretty good	1/3	1/2	1	2	3
Enough	¼	1/3	1/2	1	2
Bad	1/5	1/4	1/3	½	1

9. Change the matrix sub-criteria pair comparison into decimal numbers and add each column to the sub-criteria, as shown in Table 9.

Table 9. DECIMAL SUB CRITERIA MATRIC

	Very Good	Good	Pretty Good	Enough	Bad
Very good	1	2	3	4	5
Well	0.5	1	2	3	4
Pretty good	0.333	0.500	1	2	3

Enough	0.250	0.333	0.500	1	2
Bad	0.200	0.250	0.333	0.500	1
Total	2.283	4.083	6.833	10.500	15

10. Normalise all values by dividing each element per column by the total number of columns, as shown in Table 10.

Table 10. NORMALIZED MATRIX SUB CRITERIA

	Very Good	Good	Pretty Good	Enough	Bad
Very good	0.438	0.489	0.439	0.300	0.333
Well	0.219	0.244	0.292	0.285	0.266
Pretty good	0.145	0.122	0.146	0.190	0.200
Enough	0.109	0.081	0.073	0.095	0.133
Bad	0.087	0.061	0.048	0.047	0.066

11. Calculate the normalized eigenvector by adding up each row and dividing it by the number of criteria as the results in Table 11.

Table 11. CALCULATION OF EIGEN VECTOR NORMALIZATION

	Very Good	Good	Pretty Good	Enough	Bad	Number of Rows	Eigen Vector normalization
Very good	0.438	0.489	0.439	0.300	0.333	2.079	0.415
Well	0.219	0.244	0.292	0.285	0.266	1.306	0.261
Pretty good	0.145	0.122	0.146	0.190	0.200	0.803	0.160
Enough	0.109	0.081	0.073	0.095	0.133	0.491	0.098
Bad	0.087	0.061	0.048	0.047	0.066	0.309	0.061

12. Calculate the consistency ratio:

- Calculate the highest eigenvalue (λ_{maks})

Done by adding up the results of the multiplication values in the table with the values in Table 11.

$$\lambda = (2.283 * 0.415) + (4.083 * 0.261) + (6.833 * 0.16) + (10.5 * 0.098) + (15 * 0.061) = 5.050388$$

- Calculate the consistency index (CI)

$$CI = \frac{\lambda_{maks} - n}{n - 1} = \frac{5.050388 - 5}{5 - 1} = 0.012$$

- Consistency ratio

RC = there are 5 criteria, the value is 1.12

$$CR = \frac{CI}{RC} = \frac{0.012}{1.12} = 0.01$$

Because $CR < 0.100$ the weighting preferences are consistent

13. Finally, determine the ranking of alternatives by calculating the eigenvector for each criterion and sub-criterion. The weight value is obtained from the conditions owned by the alternative. The value of the violation is 0 (very good) then it is given a weight 1. Attendance 156 (very good) then it is given a weight 1. Non-academic B (good) then given a weight 4. And academic 1530 (very good) then given a weight 1. Ahmad, the value of the violation 45 (enough), then given a weight 4. Attendance 138 (good) then given a load 2. Non-academic A (very good) then given a weight 1. And academic 1565 (very good) then given influences 1. Results are obtained from the multiplication of the criteria vector, as shown in Table 12.

Table 12. RANKING RESULTS

Name	Violation	Attendance	Non-Academic	Academic	Result
Rino	1	1	1	1	0.41334
Dian	1	1	3	1	0.37560
Caca	1	2	1	1	0.36652
Aulia	1	1	4	1	0.36642
Budi	1	2	3	2	0.31985
Roni	1	3	2	1	0.31303
Rina	3	1	1	2	0.28048
Budi	2	2	1	3	0.27689
Deni	2	3	1	1	0.26098
Ahmad	4	2	1	1	0.21246

III. RESULTS AND DISCUSSION

A. System Design

The system design compiled in this study uses a use case diagram and entity relationship diagram. Use case diagram illustrates the functionality in a parallel ranking decision support system [16] as shown in Figure 4.

Figure 3 shows an overview that takes place on a student ranking list decision supports web system. Students can see student info and ranking list if they have logged in and have been registered by the admin. Homeroom can manage academic and non-academic grades if they are logged in and have been recorded in the admin database. Admin can manage the user, manage the values that have been entered by the homeroom teacher and can run a decision support system when logged in to the system.

Entity Relationship Diagram (ERD) is a diagram that shows objects and relationships between objects using identity and relationship [17]. ERD web decision support list of student rankings is shown in Figure 3.

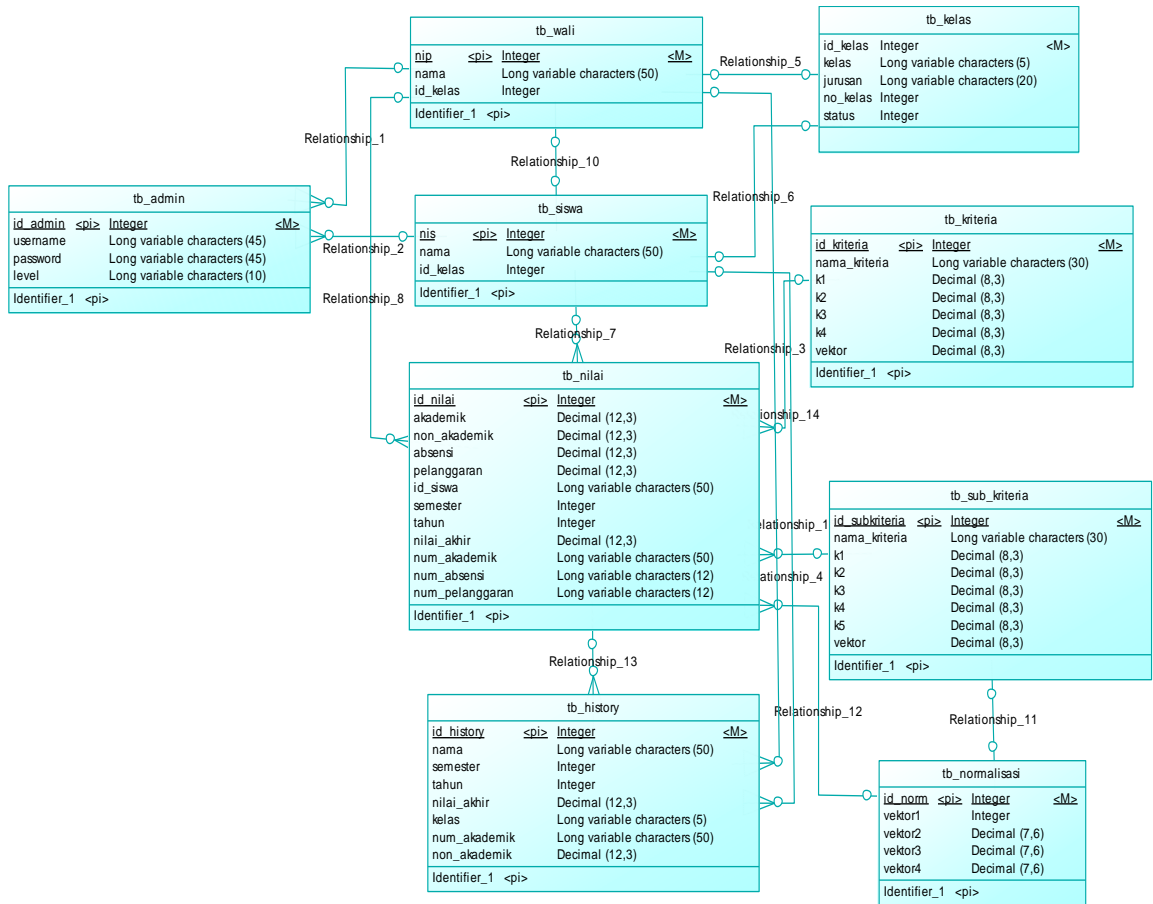


Figure 3.ERD SYSTEM

B. Implementasi Sistem

To be able to access the support system of parallel ranking decision, all users are required to log in according to their user name and password. After the admin has logged in, the admin home page will be displayed, as shown in Figure 5.

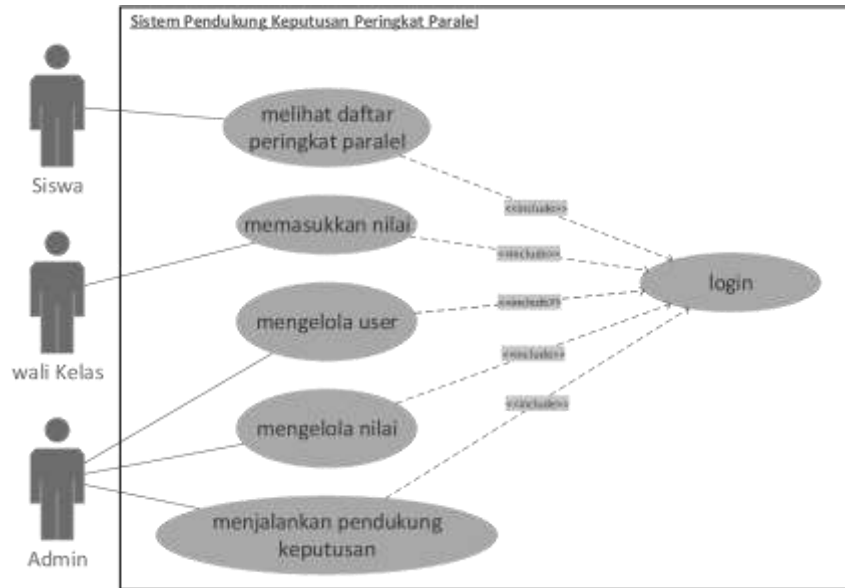


Figure 4. USE CASE DIAGRAM SYSTEM



Figure 5. HOME ADMIN

On the admin homepage, there are the Users, Data, AHP, Final Value, and Ranking Lists menus. The user page is useful for managing accounts that contain registered user information, setting levels, and passwords of users shown by Figure 6.

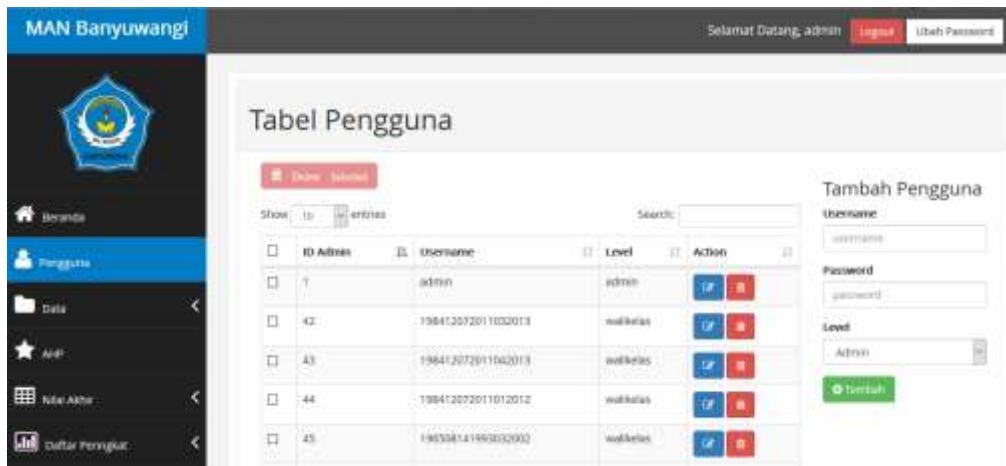


Figure 6. USER PAGE

The Data menu has three submenus, namely class data, student data, and homeroom data. The class data page is used to manage and display class information in the Banyuwangi MAN school, shown in Figure 7.

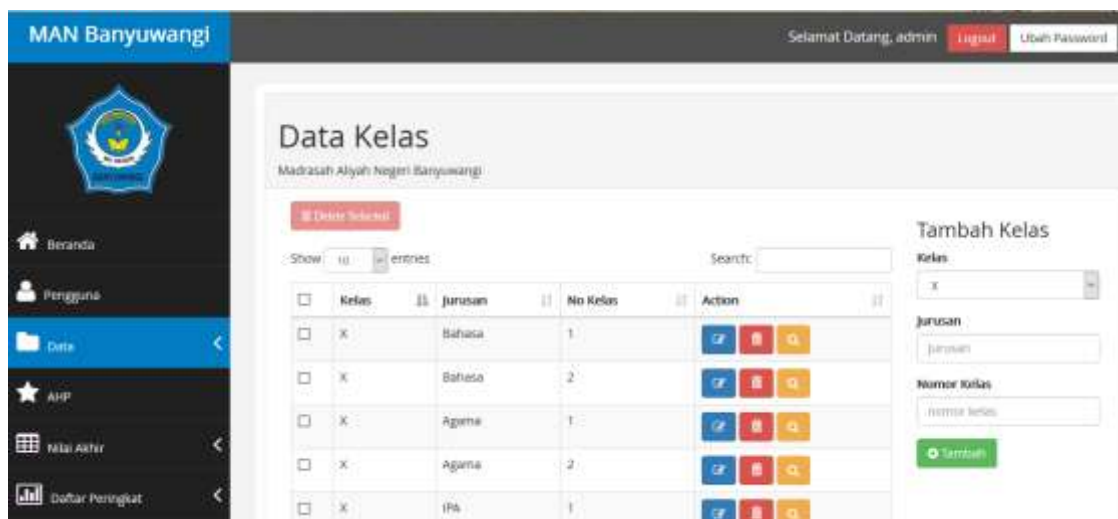


Figure 7. CLASS DATA DISPLAY

The student data page is used to manage and display student information in the Banyuwangi MAN school such as the Student Identification Number, name of the student, and a class of students, which is shown in Figure 8. Whereas the homeroom data page is used to manage and display the information of the homeroom teacher in MAN Banyuwangi schools such as Employee Main Number, name of homeroom teacher, and homeroom class as shown in Figure 9.

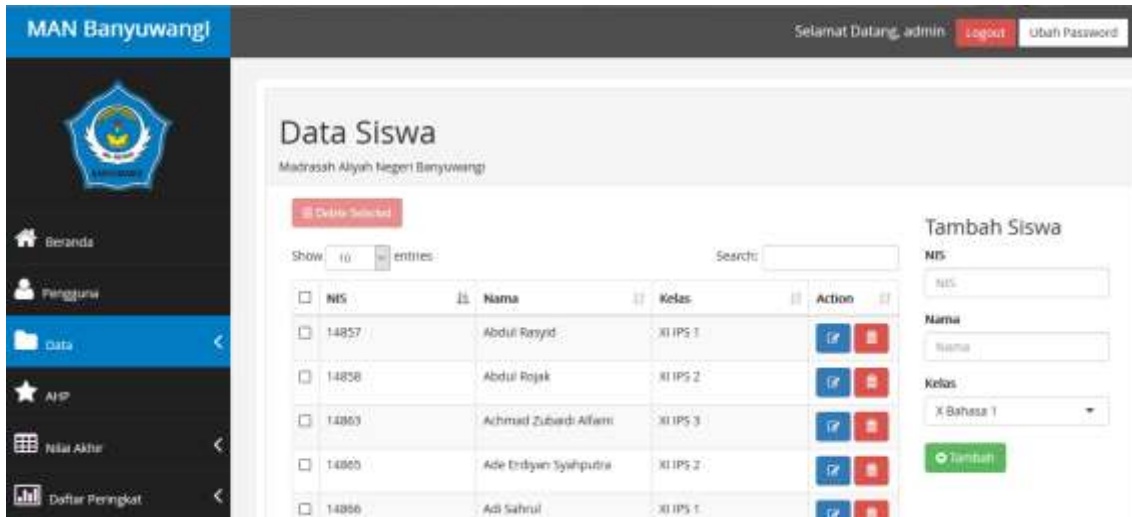


Figure 8. DISPLAY STUDENT DATA

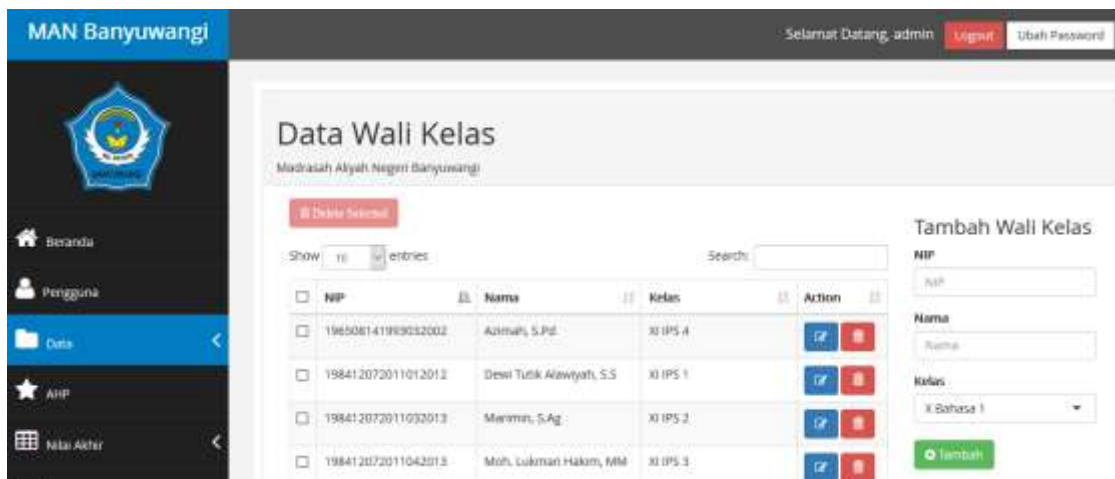


Figure 9. CLASS GUARDIAN DATA VIEWS

AHP display is a menu for processing student grades that have been entered by the homeroom teacher using the AHP method as in Figure 10.

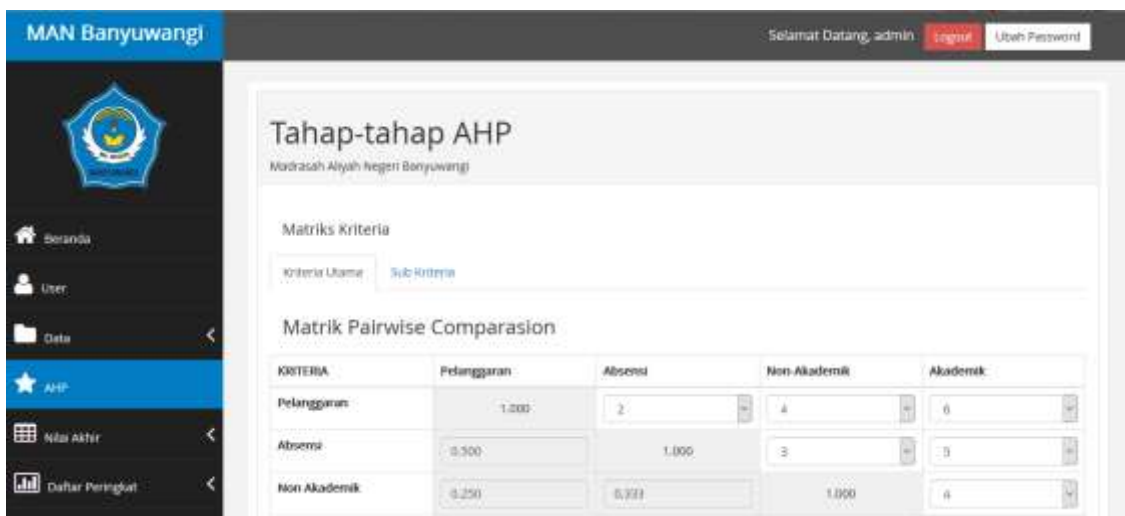


Figure 10. AHP DISPLAY

In Figure 10, there are value criteria used to determine student rankings following the method used, the AHP method. Here the criteria used are determined in advance following the provisions in the AHP. All grades used in the AHP process are entered first by each homeroom teacher in the form of violations, absences, non-academic values, and academic values, as shown in Figure 11. The system then converts these values following Table 3.

Figure 11. PAGE MANAGE VALUE

The system then performs the results of the AHP calculation of all the criteria according to the AHP flowchart in Figure 2, and the results can be seen on the final value page shown in Figure 12. On this page, the value of each AHP process result criteria for all students is displayed. Furthermore, the amount will be multiplied by the criteria weight to get the final value which is then sorted to get the ranking, as shown in Figure 13.

Figure 12. LOOK AT THE END VALUE EVERY CRITERION

Ranking list display is a student ranking list display from the results of the value processing process, which is shown in Figure 13. Each student can see the ranking of the AHP ranking according to their respective majors. To be able to see it, students enter the username and password that they have on the user's login page.

NIS	Nama	Hasil	Ranking
14927	Bella Yulinda	0.399	1
14874	Ahmad Aulka Robby	0.399	1
14882	Aldy Firanda	0.399	1
15126	Nisa Oktaprio	0.395	2
14987	Fadly Robby Alfandi	0.395	2
15010	Ibham Saifulloh	0.395	2
15105	Muhammad Rizki Maulana	0.395	2
14951	Dimas Angga Prayogo	0.352	3
14934	Anita Firdaus	0.352	3

Figure 13 DISPLAY RANK LIST

C. System Testing

System testing is an important thing to do to find out whether the system made runs according to its function or not [18]. The method used by the author is black box testing that is testing carried out by observing the results of system operation. Blackbox test results are in Table 13.

Table 13. BLACK BOX TESTING RESULTS

Test Case	Which is expected	Observation	Status
Login Admin	Can enter the main admin page display	Can open the main admin page display	Corresponding
Add class data	Displays a form for entering class data	Class data is added and stored	Corresponding
Add student data	Displays a form for entering student data	Student data is increased and stored	Corresponding
Add homeroom data	Displays a form for entering homeroom data	Homeroom data is added and stored	Corresponding
Change class data	Display the form change class data and save data changes	Data changes according to the actual data	Corresponding
Change student data	Displays form change student data and save data changes	Data changes according to the actual data	Corresponding
Change homeroom data	Displays the data form of the homeroom teacher and saves the data changes	Data changes according to the actual data	Corresponding
Add user data	Displays a form for entering user data	User data is added and stored	Corresponding

Change user data	Display the form change user data and save data changes	Data changes according to the actual data	Corresponding
AHP Process	Entering the weight of the assessment in each student's criteria	Data stored and processed	Corresponding
The final value	Displays the results of the student's final grade	Showing final results	Corresponding
Enter student grades	Homeroom teachers enter student grades	Student grades that have been entered by the homeroom teacher will be entered into the ranks on the system.	Corresponding
Change student grades	Homeroom teacher changes student grades	Student grades that have been altered by the homeroom teacher will be entered into the ranks on the system.	Corresponding

Testing several aspects of the application to users is also done to all system users according to the level of access rights, including admin (administrative staff), homeroom teacher, and students. After the user uses the system, they are asked to rate the system through a questionnaire based on ISO 9126 [19]. The results of the questionnaire gave a final value of 92.29%, which was well received by the user, as in Table 14.

Table 14. USER QUESTIONARY RESULTS

No	Aspect	Average value
1	Functionality	90,96%
2	Reliability	85,60%
3	Usability	96,60%
4	Efficiency	96,00%
Average total		92,29%

IV. CONCLUSIONS AND RECOMMENDATIONS

In this study, a parallel class ranking model has been developed using the Analytic Hierarchy Process (AHP) method with multiple criteria in Banyuwang State Aliyah Madrasah by using four criteria, namely academic grades, non-academic values, violation scores, and absenteeism. The system is built on a web-based and has been tested using the black box testing method with relevant results, and the results of the user questionnaire obtained 92.29% of the system can be well received. The system can be completed by displaying graphs of the development of student achievement each semester.

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