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Intelligent system for college selection with analytical hierarchy process method case study approach

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Abstract: This research aims to develop an innovative decision support system to assist students of SMK Ibnu Sina in selecting universities in Batam City according to their preferences. In order to make the right decision, prospective students must survey information about Batam City universities. With this information, prospective students can assess universities based on accreditation, registration fees, facilities, convenience, and study programs offered to choose the university that best suits their educational needs. The System Development Life Cycle (SDLC) method with a waterfall model is used as a framework to design an effective web-based information system. Data was collected through literature studies and interviews with counseling teachers to establish essential criteria in the college selection process. Based on the results of this analysis, the developed information system includes features such as criteria weighting using the Analytical Hierarchy Process (AHP) method, alternative evaluation, and college ranking. Thus, this SPK is designed to provide accurate and reliable recommendations, expected to increase students' confidence in making decisions regarding colleges that best suit their needs and goals.

Keywords: Decent work and economic grouwth; Decision science; Data checking; Sequential manner; Development life cycle

1. Introduction

In the modern era, the development of technology has brought us into an increasingly complex and sophisticated world (Fortuna et al., 2024; Muskhir et al., 2024; Prasetya et al., 2024). Artificial intelligence (AI) is one technological development garnering attention and changing how we interact with the world is artificial intelligence (AI) (Thurzo et al., 2023; Vrontis et al., 2022). In various sectors, including education, AI greatly simplifies processes, improves efficiency, and provides intelligent solutions. In the context of college selection in Batam, an AI-based decision support system can be an innovative solution to simplify the selection process for prospective students (Chen et al., 2023; Gligorea et al., 2023; Rudolph et al., 2023). Despite the great potential of AI, its implementation does not always go smoothly. College selection is a complex process involving many factors to consider. Challenges include the complexity of data collection and analysis, system sustainability, and difficulty assessing many criteria relevant to college selection decisions.

Many students of SMK Ibnu Sina (Vocational High School) have difficulty deciding on a college, where the selection process should be based on the abilities and needs of the prospective students. The number of universities in Batam City that offer various advantages, such as accreditation and facilities, confuse prospective students when choosing the best college. To make the right choice, prospective students must survey information on universities in Batam City. With this information, prospective students can assess universities based on accreditation, registration fees, facilities, convenience, and study programs offered to ensure which universities are most suitable for continuing their education

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(Daultani et al., 2021). It is not uncommon for prospective students to choose a college major carelessly without considering their future during lectures and after graduation. This can lead to low academic grades and hinder graduation.

The Decision Support System is designed to assist a person or organization in making decisions by providing relevant information, analysis, and mathematical models (Kumar, 2020). Decision support systems help overcome complexity and uncertainty in decision-making by providing timely support and information (Chaudhuri & Bose, 2020; Moallemi et al., 2020). The method used in this SPK is the Analytical Hierarchy Process (AHP). AHP is a method developed by Thomas Saaty in the 1980s and has been widely used in various fields, including educational decision-making (Ekmekcioğlu et al., 2021; Leal, 2020).

AHP is a comparison-based technique that helps decompose relevant factors and compare their priorities in a structured manner. AHP allows prospective students to overcome the complexity of college selection by decomposing important factors and performing pairwise comparisons to determine the relative weight of each factor (Xing et al., 2024). The AHP method has proven effective in addressing the complexity of multi-criteria decision-making. By using AHP, prospective students can consider important factors such as college reputation, study program accreditation, campus facilities, tuition fees, and curriculum in choosing a college that best suits their preferences (Nuseir & El Refae, 2022; Qasim et al., 2021).

Based on the explanation above, a decision support system is made to help prospective students choose their majors in college using the analytical hierarchy process method. This research aims to create a Decision Support System for college selection in Batam City using the AHP method. This research is expected to provide more straightforward and structured guidance for prospective students in choosing a college that suits their needs and preferences. With this SPK, it is expected that prospective students in Batam and from other regions can make more informed and satisfying decisions in determining universities that match their expectations and goals.

2. Methods

The data in this study was collected through various systematic methodological approaches. The author used questionnaires as the main instrument to collect data from respondents. In addition, direct observation was conducted to observe the situation and collect field data relevant to the design of a decision support system for college selection in Batam, using the Analytical Hierarchy Process (AHP) method (Dar et al., 2021; Wang et al., 2021). Before collecting data, the author conducted an in-depth introduction to the research object's environment and relevant materials. Interviews were also conducted directly with the Counseling Guidance Teacher to obtain research and system design information.

After the necessary data is collected, the next step is data processing. This process involves the stages of Data Checking, Classifying, Verifying, and Conclusion to ensure the accuracy and reliability of the data used in the analysis. In designing the system, the author applies the SDLC method with a waterfall model, which allows the system design process to be carried out in a structured and sequential manner, ensuring that each stage of development can be completed properly before moving on to the next stage (Christanto & Singgalen, 2023; Pinciroli et al., 2022). The following is a visualization of the Software Development Life Cycle used as a research method presented in Figure 1.

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Figure 1. Software development life cycle

3. Results and discussion

3.1 Needs analysis

This stage aims to detail all the requirements to comprehensively describe what is expected from the system to be developed. This analysis aims to produce innovative and effective solutions that meet user needs and improve operational efficiency. At the needs analysis stage, various essential elements are identified and analyzed to ensure that the information system to be designed can meet all the requirements set. Needs analysis includes collecting information from various sources, such as end users, direct observation, and interviews with relevant parties. The data obtained is then categorized and validated to ensure its accuracy.

By conducting an in-depth needs analysis, the development team can clearly understand the features and functionality that must be present in the system. This includes mapping user needs, identifying existing business processes, and determining relevant technical parameters. This analysis not only focuses on the technical aspects but also considers the human and organizational factors involved in using the system. By understanding the needs in-depth, the next step is to design a system that can fulfill these needs optimally. This process involves drafting detailed specifications that guide the development of the system, ensuring that every element required is identified and appropriately planned.

3.2 Design of dicision support system

At this stage, we will explain the design of a decision support system for selecting universities in Batam using the web-based Analytical Hierarchy Process (AHP) method at MI Al-Muhajirin. In designing this system, the author uses UML (Unified Modeling Language) modeling tools, which include four principal diagrams: Use Case Diagram, Activity Diagram, Class Diagram, and Sequence Diagram.

Figure 2 Usecase diagram contains several interconnected nodes describing a system or process. This flowchart has two separate sections, each starting with the node "Home." The left section includes nodes labeled "User," "Login," and "Profile Data," which connect to a central node titled "Final Result Data." This section also features an "Admin" node connected to the same central node. The right section of the flowchart expands from the "Home" node by adding other nodes labeled "Dashboard," "Criteria Data," "Alternative Data," and "Calculation Data" and connects back to the central node "Final Result Data".

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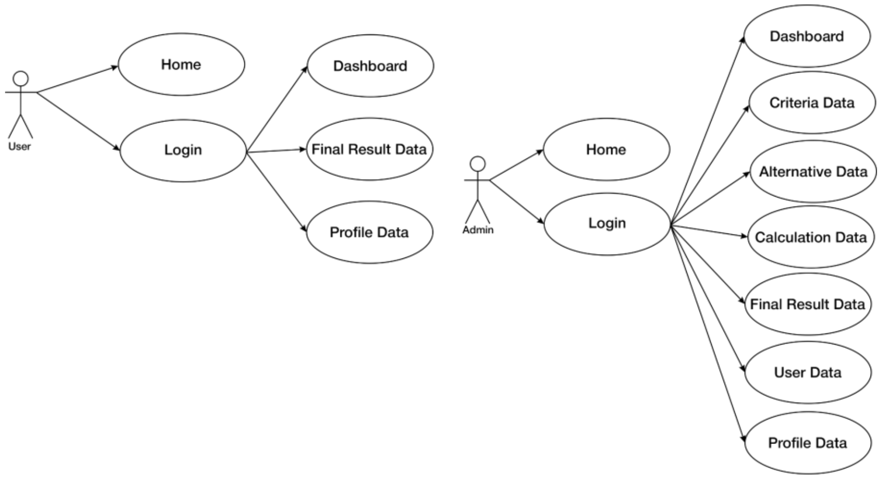


Figure 2.
Usecase diagram

In addition, there are connections to nodes labeled "User Data" and "Profile Data." This flowchart probably depicts the user interface structure for the software where regular users and admins can log in, view profiles, and access final result data through different paths. This figure is fascinating because it illustrates how different types of data are interconnected in this system and shows multiple access points for various users.

Figure 3 on the Activity Diagram contains two diagrams labeled "User Activity Diagram" and "Admin Activity Diagram," which describe system processes. Both diagrams use standard Unified Modeling Language (UML) symbols: ovals for start/end points, rectangles for processes or actions, diamonds for decision points, and arrows indicating flow direction. These diagrams are attractive because they visually represent how users and admins interact with the system, highlighting the decision-making process and the actions taken based on those decisions.

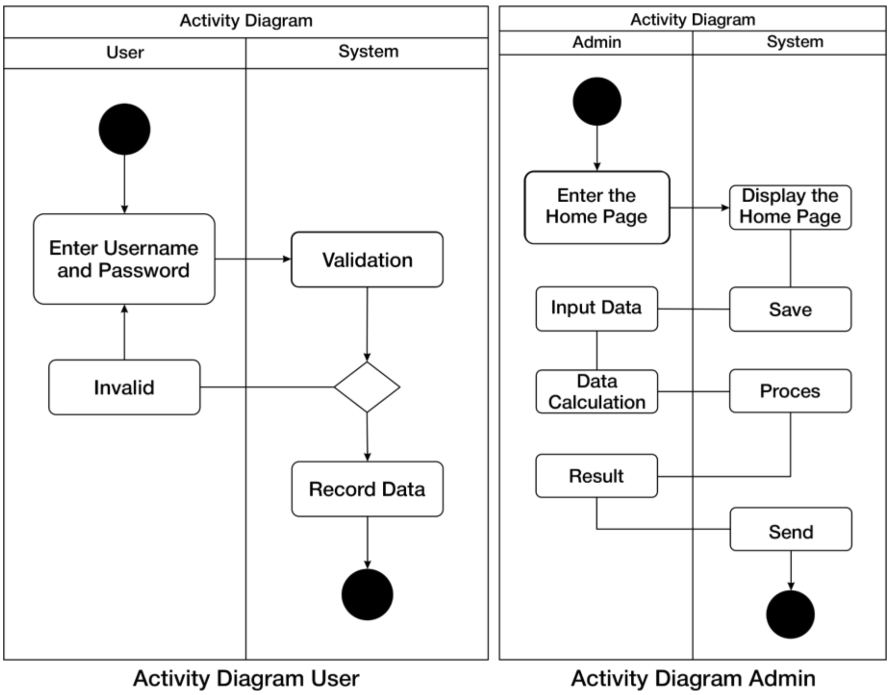


Figure 3.
Activity diagram

The "User Activity Diagram" shows a flow that starts with the user entering a username and password, which then undergoes a validation process. If the input is invalid, the flow returns to the beginning; if it is valid, the process continues to data logging and ends. The "Admin Activity Diagram" starts with the admin accessing the main page and entering data through a data calculation step. This calculation results in an activity where the system displays the main page. There are additional steps for saving, processing, and sending that lead to the end of this flow.

Figure 4.
Class diagram

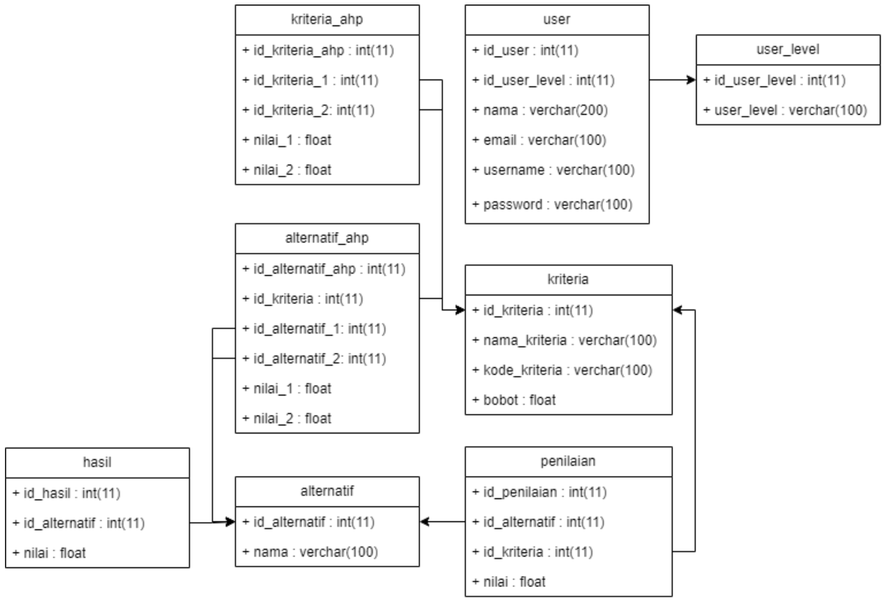
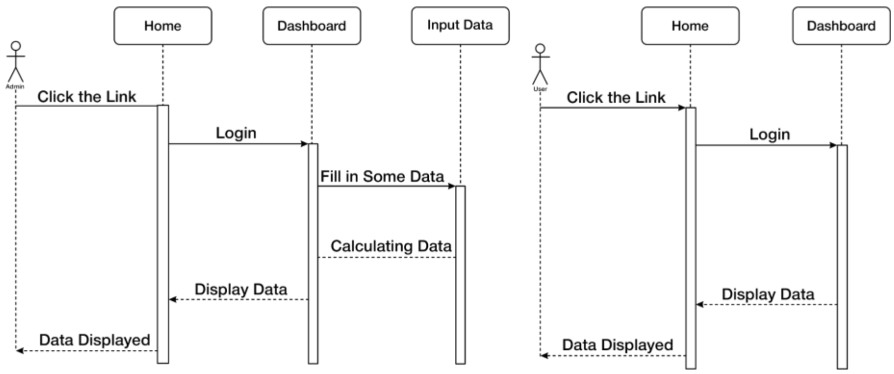


Figure 4 Class Diagram is a structural diagram in UML that, in detail, displays the class structure, including descriptions of attributes, methods, and relationships between objects. These diagrams are static, describing existing relationships without describing interactions between classes. Figure 5 shows two sequence diagrams labeled "User Activity Diagram" and "Admin Activity Diagram," which depict system processes.

Figure 4.
Class diagram



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3.3 Testing

This test ensures the system functions according to predefined requirements and adequately meets users' needs. The testing process comprehensively evaluates the system's response to pre-prepared test

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data. The first step is functionality testing, which ensures that every feature and function in the system works as expected. This includes verifying that the inputs are processed correctly and that the outputs follow predefined requirements. Next, performance testing is conducted to assess the efficiency and speed of the system in handling various workloads, including system response time, resource usage, and the capacity of the system to handle large volumes of data and the number of users accessing it simultaneously.

To ensure stability, reliability testing was conducted under various operating conditions. The aim is to ensure the system continues functioning correctly, even in challenging or unusual situations. The test data used in testing was prepared based on realistic usage scenarios, covering a wide variety of inputs that the system might receive, both valid and invalid, to evaluate how the system handles each type of input. The test data is fed into the system, and the system's response is observed and analyzed. Each module is tested individually, and then the entire system is tested as a whole to ensure that all components function correctly and in an integrated manner. All test results are documented in detail, including any findings, errors, or anomalies detected, a description of the problem, steps to reproduce the problem, and the potential impact on the system.

Once testing is complete, the data is analyzed to identify error patterns or areas that require improvement. Based on this analysis, improvements are made to the problematic parts of the system, and this cycle of testing and improvement is repeated until the system meets all established quality requirements. Testing also includes validation from end users to ensure that the developed system matches their needs and expectations. Users are asked to test the system under actual conditions and provide feedback regarding its functionality, ease of use, and reliability. Feedback from users is collected through questionnaires, interviews, or group discussions to identify areas that need improvement and ensure that the system truly meets the users' needs. Based on this feedback, enhancements are made to the system, which may include adjustments to the user interface, increased functionality, or performance improvements. The goal is ensuring the system works efficiently and satisfies all users.

3.4 Integration

The Analytical Hierarchy Process (AHP) method is an appropriate solution to accelerate and simplify the process of selecting universities in Batam by considering factors such as accreditation, cost, class schedule, and facilities. The decision support system will be developed using the AHP weight calculation method, starting with forming a hierarchical structure of three primary levels. The first level is the goal, which reflects the decision's main objective, namely the selection of the best college. The second level is criteria, which compiles the main criteria on which the evaluation is based, such as accreditation, cost, class schedule, and facilities. The third level is the subcriteria, which compiles more specific subcriteria for each main criterion, providing more detail for the evaluation.

The process of comparing data between criteria involves analyzing and evaluating data sets based on a variety of different criteria. This step aims to identify patterns, differences, or relationships between criteria to make more informative decisions based on robust data. This comparison uses a rating scale to assess the importance of one criterion against another, which is then used to calculate the relative weight of each criterion.

The AHP method compares each element in the hierarchy as a pairwise comparison matrix. The values obtained from this comparison are then processed to produce priority weights that help make the final decision. This process allows for in-depth and objective analysis, making more accurate and accountable decisions.

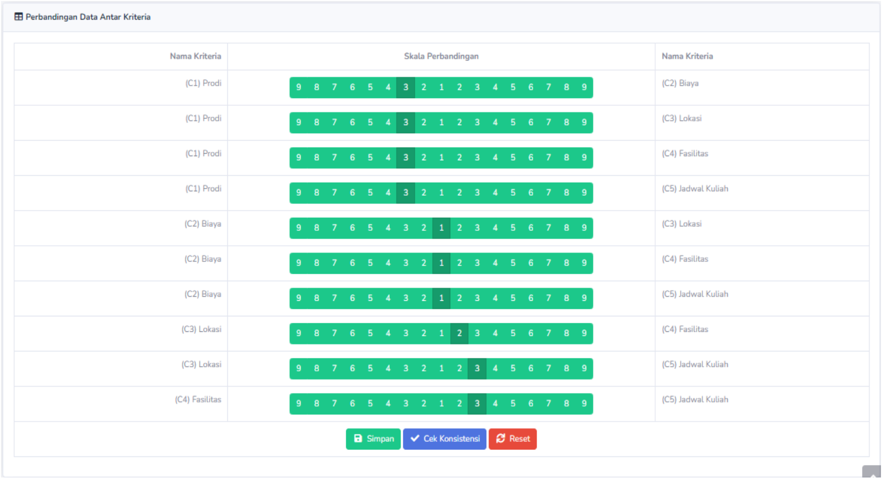


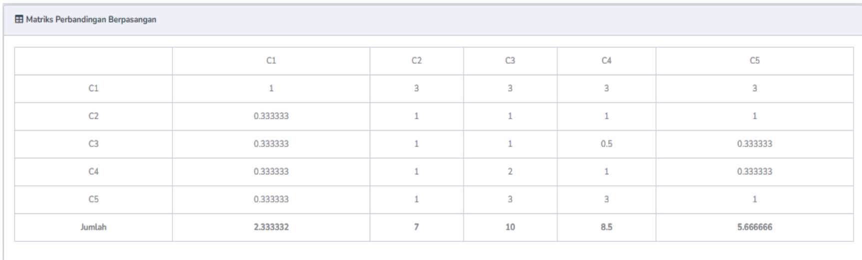
Figure 6. Software Development Life Cycle

Calculating the priority vector for criteria starts with determining the comparison scale. The comparison scale can be made by referring to Table 1, a pairwise comparison rating scale.

Table 2. Criteria comparison scale

Criteria	C1 (Study Program)	C2 (Cost)	C3 (Location)	C4 (Facilities)	C5 (Course Schedule)
C1	9	3	3	3	3
C2	3/9 = 0.33	3/3 = 1	3/3 = 1	3/3 = 1	3/3 = 1
C3	3/9 = 0.33	3/3 = 1	3/3 = 1	3/3 = 1	3/3 = 1
C4	3/9 = 0.33	3/3 = 1	3/3 = 1	3/3 = 1	3/3 = 1
C5	3/9 = 0.33	3/3 = 1	3/3 = 1	3/3 = 1	3/3 = 1

After compiling the hierarchy, the next step is to establish the priority of the elements by determining pairwise comparisons based on the relative importance between elements in the form of a matrix according to the pair comparison rating scale. This is done in the form of a matrix corresponding to the pairwise comparison rating scale, which is then used to calculate the priority vector and determine the relative weight of each criterion.



Matriks Perbandingan Berpasangan

	C1	C2	C3	C4	C5
C1	1	3	3	3	3
C2	0.333333	1	1	1	1
C3	0.333333	1	1	0.5	0.333333
C4	0.333333	1	2	1	0.333333
C5	0.333333	1	3	3	1
Jumlah	**2.333332**	**7**	**10**	**8.5**	**5.666666**

Figure 7. Pairwise comparison matrix

The number 1 in column C1 indicates that Prodi has the same level of importance as Prodi itself, while the number 3 in column C2 row C1 indicates that element C2 (Cost) is slightly more critical than element C1 (Prodi). The number 0.33 in column C1 row C2 results from the calculation of 1/value in the column concerned. A similar process is applied to the other numbers.

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Table 2. Calculating normalization for the criteria matrix

Criteria	Value	Priority	Eigen Value
C1	1/2.332 = 0.428	2.039/5 = 0.407	0.407*2.332 = 1
	3/7 = 0.428		
	3/10 = 0.3		
	3/8.5 = 0.352		
	3/5.6 = 0.529		
C2	0.33/2.332 = 0.142	0.679/5 = 0.135	0.135*7 = 1
	1/7 = 0.142		
	1/10 = 0.1		
	1/8.5 = 0.117		
	1/5.6 = 0.176		
C3	0.33/2.332 = 0.142	0.503/5 = 0.1	0.1*10 = 1
	1/7 = 0.142		
	1/10 = 0.1		
	0.5/8.5 = 0.058		
	0.33/5.6 = 0.058		
C4	0.33/2.332 = 0.142	0.662/5 = 0.132	0.132*8.5 = 1
	1/7 = 0.142		
	2/10 = 0.2		
	1/8.5 = 0.117		
	0.33/5.6 = 0.058		
C5	0.33/2.332 = 0.142	1.115/5 = 0.223	0.223*5.6 = 1
	3/7 = 0.428		
	3/10 = 0.3		
	3/8.5 = 0.352		
	1/5.6 = 0.176		

The next step is normalization. The normalization calculation process is carried out by dividing the value of each matrix element by the total value in the matrix column that was calculated previously.

Matriks Normalisasi Dan Nilai Prioritas

	C1	C2	C3	C4	C5	Jumlah	Prioritas
C1	0.42857167346953	0.42857142857143	0.3	0.35294117647059	0.52941182698963	2.0394961055012	0.40789922110023
C2	0.14285708163262	0.14285714285714	0.1	0.11764705882353	0.17647060899654	0.67983189230983	0.13596637846197
C3	0.14285708163262	0.14285714285714	0.1	0.058823529411765	0.058823477508644	0.50336123141017	0.10067224628203
C4	0.14285708163262	0.14285714285714	0.2	0.11764705882353	0.058823477508644	0.66218476082193	0.13243695216439
C5	0.14285708163262	0.14285714285714	0.3	0.35294117647059	0.17647060899654	1.1151260099569	0.22302520199138

Figure 8. Normalisation matrix and priority score

Consistency Measure is an important method used to check the consistency of judgments given by decision-makers. It ensures that pairwise comparisons between elements in the matrix do not contradict each other.

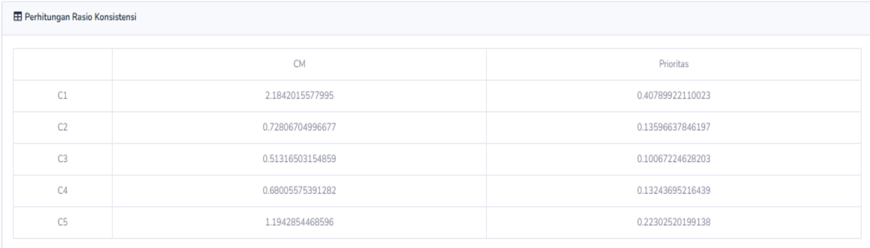
Consistency Measure (CM)

	C1	C2	C3	C4	C5	CM
C1	0.40789922110023	0.4078991353859	0.3020167388461	0.39731085649316	0.66907560597413	2.1842015577995
C2	0.135966271067	0.13596637846197	0.10067224628203	0.13243695216439	0.22302520199138	0.72806704996677
C3	0.135966271067	0.13596637846197	0.10067224628203	0.066218476082193	0.074341659655392	0.51316503154859
C4	0.135966271067	0.13596637846197	0.20134449256407	0.13243695216439	0.074341659655392	0.68005575391282
C5	0.135966271067	0.13596637846197	0.3020167388461	0.39731085649316	0.22302520199138	1.1942854468596

Figure 9. Consistency measure

From the results of the Consistency Ratio for criteria, it can be concluded that the CR value is less than 0.1 or below 10%, so the priority vector value for criteria can be concluded to be consistent.

Figure 10.
Consistency ratio calculation

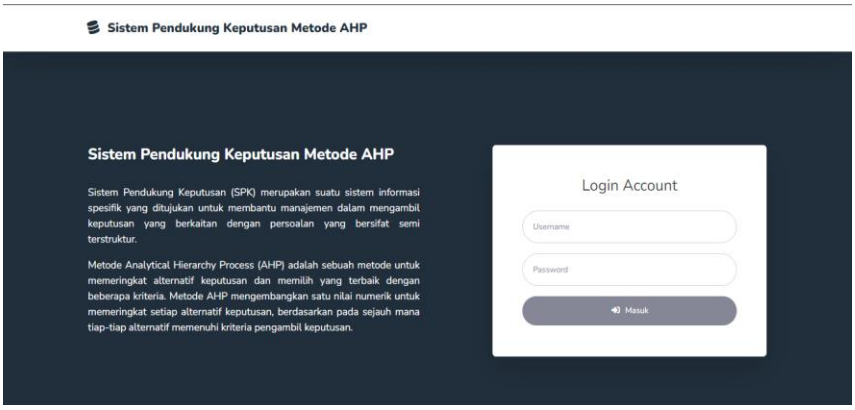

Perhitungan Rasio Konsistensi

	CM	Prioritas
C1	2.1842015577995	0.40789922110023
C2	0.72806704996677	0.13596637846197
C3	0.51316503154859	0.10067224628203
C4	0.68005575391282	0.13243695216439
C5	1.1942854468596	0.22302520199138

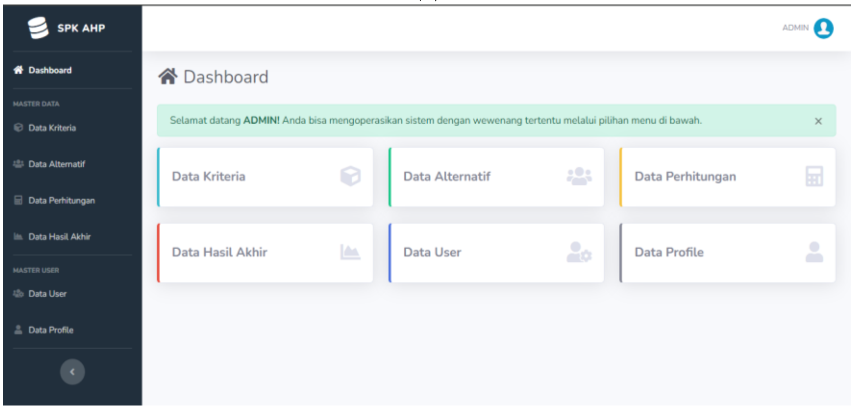
3.5 Implementation

Interface implementation involves explaining the function of each application display that has been developed. The following is a further description of the form and function of each interface implementation.

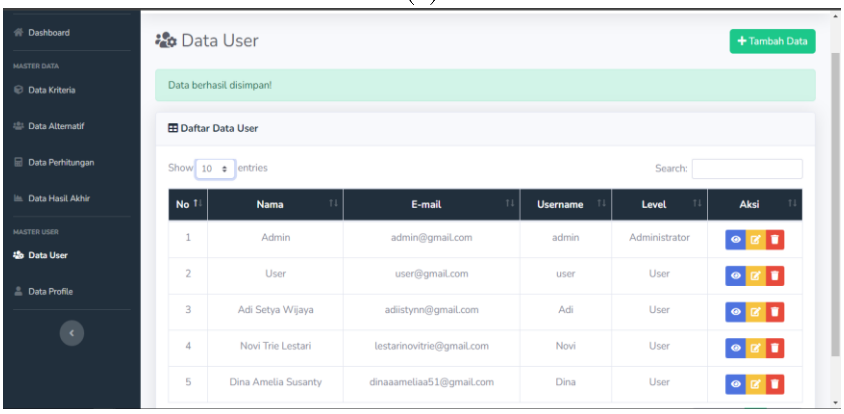
Figure 11.
Login page



(a)



(b)



(c)

4. Conclusion

This research aims to develop an Analytical Hierarchy Process (AHP)-based Decision Support System to assist prospective students in selecting universities in Batam City. The AHP method is used to overcome complexity and multi-criteria in decision-making. Based on data collection through questionnaires, direct observation, and interviews with Counseling Guidance Teachers, this research designs a structured system using a waterfall-based Software Development Life Cycle (SDLC) model. The results show that the developed system can provide clear and structured guidance for prospective students in determining colleges that suit their needs and preferences. System testing shows that the system can function as expected with reasonable consistency in comparing criteria. Thus, implementing this decision support system is expected to help prospective students make a more informed and planned decision when choosing a college and contribute to improving the efficiency of the college selection process in the future.

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Declarations

Author contribution

Nurhikmah: Conceptualization, methodology, Validation, data curation and writing - original draft. Muhammad Ropianto: Investigation, resources, writing - review & editing. Novi Hendri Adi: Writing - original draft, software, formal analysis, investigation and data curation.

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Conflict of interest

No conflicts of interest in this research

Ethical clearance

There are no human subjects in this manuscript and informed consent is not applicable. The research company has agreed to carry out the research and is willing if the results of this research are published.

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