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The Implementation of Data Mining in Measuring Student Satisfaction Levels at IAIN Kerinci

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ABSTRACT

Measuring student satisfaction is crucial to consider, given the high level of competition in the education sector alongside the advancement of knowledge and technology. It is essential to ensure that the services expected by students align with what they actually receive. Measuring student satisfaction can significantly assist higher education institutions in improving the quality of services, which in turn can impact the increase in student enrollment. This study employs a quantitative method, utilizing one of the data mining techniques, namely classification with the C4.5 algorithm, to measure student satisfaction levels. The population in this study consists of active students at IAIN Kerinci, with a sample size of 100 respondents. These students act as subjects who provide assessments or opinions on variables characterized by Tangible, Reliability, Responsiveness, Assurance, and Empathy. The data is then processed using data mining classification techniques, and testing is performed with the aid of RapidMiner software. The calculation and testing results demonstrate that data mining successfully classifies the variables in measuring student satisfaction with excellent performance, producing 10 rules from the decision tree with an accuracy rate of 98.22%. These rules are expected to serve as a basis for decision-making to determine actions that need to be taken to enhance student satisfaction.

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1. Introduction

In today's technological advancement, data has become a highly valuable commodity. Across all sectors, there is a need to effectively utilize data, including in the field of education. Higher education institutions are required to process vast amounts of data to continue growing and providing optimal services. One technique that can be used to handle large datasets is Data Mining.

From a linguistic perspective, data mining can be interpreted as "data extraction." Similar to other types of mining that dig and search for valuable minerals beneath the earth's surface, data mining also involves extracting valuable "minerals" in the form of important information needed by users from large datasets. Data mining is a term used to describe the discovery of knowledge from databases[1]. Data mining is the process of extracting information from large datasets using algorithms and methods from statistics, machine learning, and database management systems.[2]. Among the various methods used in data mining, one of the most popular is the C4.5 algorithm.[3]. The C4.5 algorithm is one of the common solutions used to

create decision trees in classification techniques, characterized by the processes of determining entropy values and gain values. It helps in splitting the data into subsets by finding the best attribute to divide the data, thereby improving the accuracy of classification models. This makes the C4.5 algorithm particularly useful for applications such as predicting student satisfaction levels, where identifying key features is crucial for making informed decisions[4].

Student satisfaction is crucial for the sustainability of the academic system in any higher education institution[5], where student satisfaction is high regarding the academic services received at the higher education institution [6], This can serve as a measurement tool to indicate that the higher education institution has good quality, which can act as a selling point to the public in attracting prospective students to enroll. Satisfaction itself is a feeling that reflects the outcome received from comparing a product or service with the expectations associated with that product or service. High student satisfaction with academic services reflects the institution's ability to meet or exceed student expectations, contributing to a positive reputation and greater student retention[7]. Satisfaction can also be defined as the feeling of contentment, joy, and relief experienced by an individual due to consuming a product or service to receive a service. In the context of higher education, student satisfaction refers to the perception of students regarding the quality of academic services they receive. When students feel satisfied with these services, it indicates that their expectations have been met or exceeded, contributing to a positive learning experience. This, in turn, can enhance student retention, reputation, and the institution's ability to attract new students[8]. Thus, satisfaction can be measured from the responses of the recipients of the product or service—whether they feel satisfied with the quality and service they received or not. In this case, it pertains to student satisfaction with the academic services provided by the higher education institution[9]. Higher education institutions can meet student expectations only if they know what students desire. Therefore, it is necessary to conduct student satisfaction evaluations regarding academic services to provide options for the institution to improve services and offer solutions on the type of service that will positively impact student satisfaction in the future. Understanding students' needs and expectations allows institutions to make informed decisions on how to enhance the quality of their academic services. Quality services that align with student expectations will not only enhance student satisfaction but also serve as a form of promotion for the institution within the community. A positive reputation and satisfied students can contribute to increased student enrollment and strengthen the institution’s position in a competitive educational landscape[10].

lthough research on student satisfaction and its impact on service quality has been extensively conducted, many studies tend to examine satisfaction factors in general terms without considering the specific characteristics of academic services in higher education institutions. Additionally, the application of data mining methods, such as the C4.5 algorithm, in analyzing student satisfaction remains relatively rare. Most studies tend to rely on descriptive statistical methods or simple regression to measure satisfaction, while the use of data mining can provide more in-depth analysis by identifying hidden patterns that may not be detected through conventional analysis. By utilizing data mining, institutions can uncover key insights and improve their academic services more effectively, leading to enhanced student satisfaction and better decision-making processes.

Therefore, this study attempts to fill the gap in the literature by applying the C4.5 algorithm to analyze more specific student satisfaction variables, namely the Tangibles, Reliability, Responsiveness, Assurance, and Empathy aspects.[11]. This approach enables the more accurate identification of key variables influencing student satisfaction and offers data-driven recommendations for universities to enhance their academic services. Through this study, it is hoped that the results will provide a deeper understanding of the factors affecting student satisfaction in higher education, as well as contribute to the advancement of literature in the field of data mining within the context of higher education.

2. Research Method

This study employs a quantitative method based on data mining using the C4.5 algorithm to measure student satisfaction levels at IAIN Kerinci. The research methodology begins with the collection of primary data through questionnaires designed to measure five dimensions of academic service quality: Tangibles, Reliability, Responsiveness, Assurance, and Empathy. The use of questionnaires enables the direct collection of data from students as the primary respondents, providing quantitative data on their perceptions of academic services[12].

The population in this study consists of all active students at IAIN Kerinci who have interacted with campus academic services, such as administrative services, academic information services, and the use of educational facilities. Active students were chosen as the population because they are the direct users of academic services and have reliable experiences and perceptions for measuring their satisfaction levels with the services provided. The total population is estimated to range from hundreds to thousands of students, depending on the latest academic year's data on active student enrollment. This large and diverse population

ensures that the study captures a broad range of perspectives, providing a comprehensive understanding of the overall student satisfaction with academic services.

This study uses a purposive sampling technique to obtain relevant samples, consisting of 100 respondents. Purposive sampling was chosen to ensure that only students meeting specific criteria were selected as respondents, namely those who have experience or have utilized academic services at IAIN Kerinci. This technique allows researchers to select respondents with specific characteristics, ensuring that the data collected more accurately and relevantly represents the perceptions of the population. By focusing on respondents who meet these criteria, the study aims to provide targeted insights into the quality of academic services and their impact on student satisfaction.

The sampling process was carried out by identifying students who met the criteria through announcements in classrooms, online platforms, and directly at academic service locations such as campus administration offices and the library. This approach helps ensure diversity in the students' backgrounds, including their fields of study, levels of education, and frequency of service use. As a result, the data collected reflects a wide range of perspectives on the quality of academic services provided by IAIN Kerinci. This diverse representation strengthens the study's findings and ensures a more comprehensive understanding of student satisfaction.

The research methodology was carried out systematically and serves as a guide for researchers to conduct the study, ensuring that the results obtained do not deviate and that the intended objectives are achieved correctly in accordance with the predetermined goals. A structured approach ensures that each step of the research process aligns with the research objectives, enhancing the reliability and validity of the findings.

3. Result and Discussion

The low rate of increase in student enrollment has made it challenging for the institution to determine effective actions to significantly boost the number of students, despite numerous efforts such as off-campus promotions. Considering this issue, the institution is deemed necessary to take measures such as assessing student satisfaction, as such activities have not been conducted to date. The purpose of measuring student satisfaction is to determine whether the services provided by the institution meet students' expectations. This effort stems from the understanding that the quality of services provided to students is considered the most effective form of promotion. Additionally, it enables the institution to identify which aspects of service have the most significant impact on student satisfaction, so those services can be further improved. By addressing these key areas, the institution aims to enhance its appeal and ultimately increase student enrollment.

This study will provide information on the criteria that underlie student satisfaction with the facilities and services provided by the campus. The input for this research is the results of distributed questionnaires, while the output is the conditions under which students feel satisfied with the facilities and services offered. The outputs of this study are divided into two categories: Satisfied and Not Satisfied. Based on the generated output, data mining is employed using classification techniques, as this method involves categorical variables that yield insightful information. The classification process aims to identify patterns and relationships within the data to better understand the factors influencing student satisfaction:

a. Data Selection involves combining data from multiple sources to ensure the dataset is comprehensive and relevant to the research objectives.
b. Data Cleaning is conducted to remove inconsistent data and noise, ensuring the dataset is accurate and reliable for analysis.
c. Data Transformation involves converting the data into a suitable format for mining, enabling efficient processing and analysis.
d. Data Mining is the essential process where intelligent methods are applied to extract data patterns. This is followed by Pattern Evaluation, which identifies truly interesting patterns that represent knowledge based on specific criteria or actions deemed significant.

In this study, five criteria are established to measure student satisfaction: Tangible, Assurance, Reliability, Responsiveness, and Empathy. Once all criteria have been classified, the data collected from the questionnaires filled out by students is then transformed according to the classification results of each criterion. This transformation process ensures that the data is aligned with the relevant categories, allowing for a more accurate analysis of student satisfaction based on each specific criterion.

From the transformed data according to the criteria, a decision tree will be created to measure student satisfaction based on the predetermined criteria. There are four steps in building a decision tree using the C4.5 algorithm[13]:

a. Preparing the Training Data: The training data will be taken from data that has already been grouped into specific classes, which are extracted from a pre-existing database, also referred to as historical data. This data serves as the foundation for training the decision tree model.
b. Calculating the Root of the Tree: The root is selected based on the gain calculation of each attribute, where the attribute with the highest gain will become the first root. To calculate the gain value of each attribute, the entropy of the dataset is first computed using the following formula :

$$Entropy(S) = \sum_{i=1}^{n} - pi \times \log_2 pi \quad (1)$$

Explanation of the formula :
S = The set of cases (or instances) in the dataset
n = The number of partitions or distinct classes in the set S
pi = The proportion of instances in subset SiSi relative to the total set S

c. After obtaining the entropy value, the next step is to calculate the gain using the following formula :

$$Gain\ (S, A) = Entropy(S) - \sum_{i=1}^{n} \frac{|Si|}{|S|} \times Entropy\ (Si) \quad (2)$$

Explanation of the formula :
S = he set of cases (or instances) in the dataset
A = Feature
n = Number of Parities of attribute A
|Si| = Number of cases in parity i
|S| = Number of cases in S

d. Repeat the previous process in each branch, until all cases in the branch have the same class.

In making a decision tree, what must be done is to calculate the number of cases, the number of cases for the decision "Satisfied" (S1), the number of cases for the decision "Not Satisfied" (S2) and cases divided based on the attributes Tangibles, Assurance, Reability, Responsiveness, Empathy, then calculate the gain for each attribute.

To select an attribute as a root, it is based on the highest gain value of the existing attributes. Entropy value is needed to determine the highest gain...

Table1. Highest Gain Calculation

Node 1	Total	Satisfied	Dissatisfied	Entrophy	Gain
Total	100	82	18	0,6801	
Tangible					0,2894
High	36	36	0	0,0000	
Medium	48	42	6	0,5436	
Low	16	4	12	0,8113	
Assurance					0,3761
High	52	52	0	0,0000	
Medium	39	30	9	0,7793	
Low	9	0	9	0,0000	
Reliability					**0,4771**
High	48	48	0	0,0000	
Medium	36	33	3	0,4138	
Low	16	1	15	0,3373	
Responsiveness					0,4256
High	53	53	0	0,0000	
Medium	33	28	5	0,6136	
Low	14	1	13	0,3712	
Empathy					0,3863
High	48	48	0	0,0000	
Medium	35	31	4	0,5127	
Low	17	3	14	0,6723	

From the calculations in the table above, it can be seen that the attribute with the highest gain is Reliability, with a gain value of 0.4771. Therefore, this attribute is used as the root node or node 1, where the values for Medium and Low attributes still need to be calculated further.

The decision tree formed can be seen in the following image.

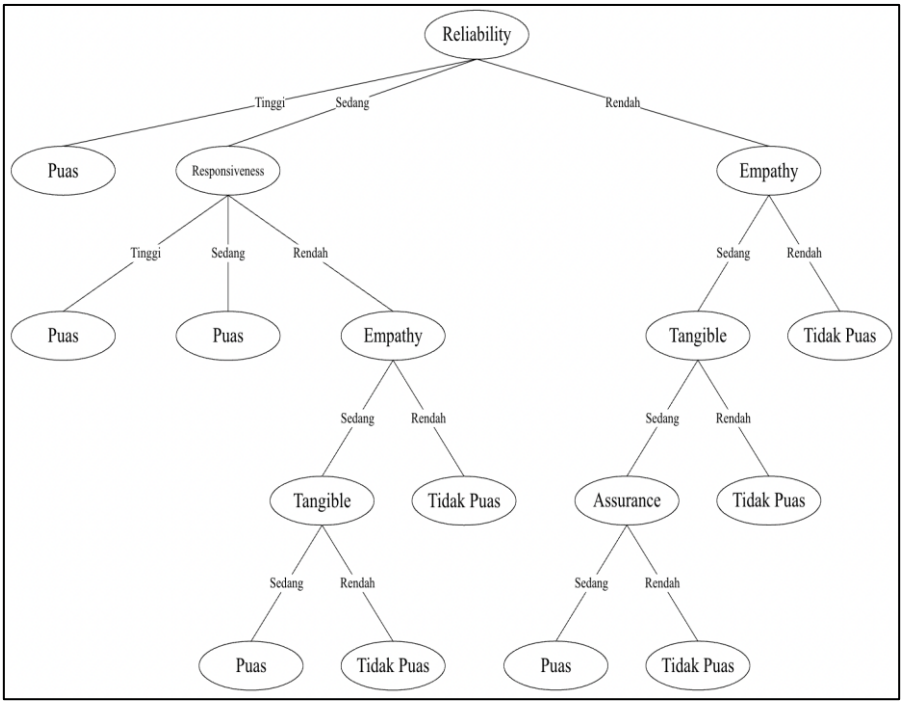

Figure 1. Resulting Decision Tree

The rule results from the calculation based on the last decision tree formed according to the calculation of Entropy and Gain. Through the decision tree, 10 rules are obtained in measuring student satisfaction. The rules or rules formed are as follows:

1) IF Reliabilty = High THEN Decision = Satisfied
2) IF Reliability = Medium AND Responsiveness = High THEN Decision = Satisfied
3) IF Reliability = Medium AND Responsiveness = Medium THEN Decision = Satisfied
4) IF Reliability = Medium AND Responsiveness = Low AND Empathy = Medium AND Tangible = Medium THEN Decision = Satisfied
5) IF Reliability = Medium AND Responsiveness = Low AND Empathy = Medium AND Tangible = Low THEN Decision = Tidak Satisfied
6) IF Reliability = Medium AND Responsiveness = Low AND Empathy = Low THEN Decision = Tidak Satisfied
7) IF Reliability = Low AND Empathy = Medium AND Tangible = Medium AND Assurance = Medium THEN Decision = Satisfied
8) IF Reliability = Low AND Empathy = Medium AND Tangible = Medium AND Assurance = Low THEN Decision = Tidak Satisfied
9) IF Reliability = Low AND Empathy = Medium AND Tangible = Low THEN Decision = Tidak Satisfied
10) IF Reliability = Low AND Empathy = Low THEN Decision = Tidak Satisfied

Of the 10 Rules obtained, there are 5 Rules with Satisfied Decisions and 5 Rules with Unsatisfied Decisions.

The decision tree formed can be seen in the following image. Testing of the analysis is very important to find and ensure whether the results of manual analysis using the Data Mining algorithm C4.5 are in accordance with the expected decision by testing data using RapidMiner Studio software. The results of testing using RapidMiner Studio software can be seen in the following figure. This testing process plays a crucial role in validating the accuracy and reliability of the model generated through the C4.5 algorithm. By running the model with test data, we are able to compare its predictions with the actual outcomes, ensuring the model's effectiveness. Any discrepancies or errors observed can help identify areas for improvement, guiding adjustments to enhance the model's performance. Through this process, we can ensure that the decision tree not only works in theory but also accurately reflects real-world data, providing insights and predictions that align with the expected results in practical applications.

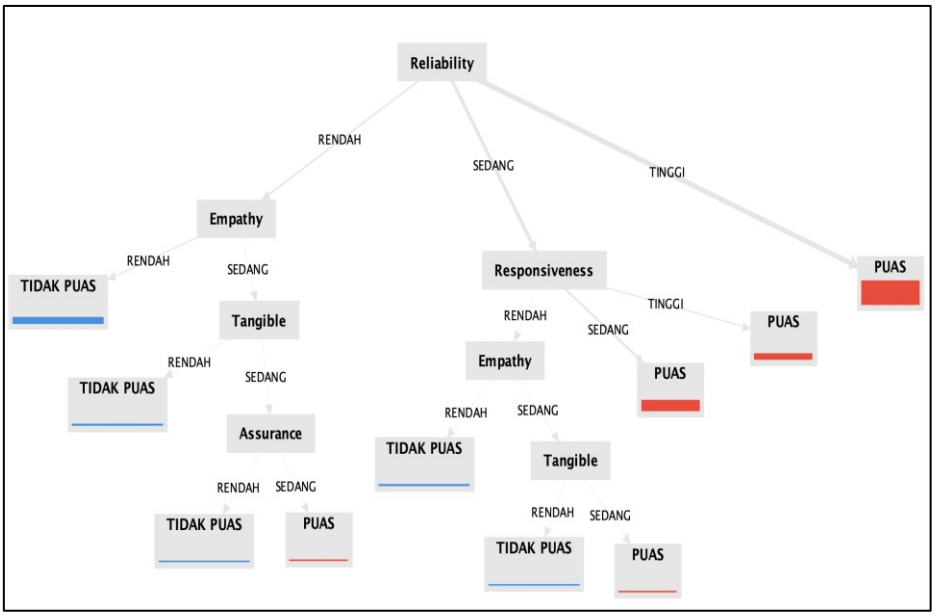

Figure 2. Decision Trees in RapidMiner

Based on the results of the C4.5 algorithm data mining test, which has been carried out through both manual calculation testing and testing using RapidMiner Studio software, it can be concluded that the test results in the form of a Decision Tree and the rules generated from both tests are very good and consistent. The rules produced from both methods are identical, confirming the reliability of the algorithm[28] [29]. The C4.5 algorithm proves to be a highly effective tool for classifying data, as it provides a clear and interpretable representation of the classified data. This clarity is evident not only in the form of a well-structured Decision Tree but also through the easily understandable if-then rules. These characteristics make it easier for users to extract meaningful information from the data, thereby enhancing the overall data mining process. By providing both a visual structure and straightforward rules, the C4.5 algorithm simplifies the task of understanding and utilizing complex data for decision-making purposes[30].

4. Conclusion

Based on the research results obtained from this study, it can be concluded that data mining with the C4.5 algorithm successfully classified variables in measuring the level of student satisfaction which produced 10 rules from the Decision tree with an accuracy level of 98.22%. The resulting rules are expected to be used as a basis for making a Decision in determining what actions should be taken to increase student satisfaction. Implementation of the C4.5 algorithm by utilizing RapidMiner Studio software in measuring the level of student satisfaction is more effective and faster in processing its data. The Decision tree formed from the test results using RapidMiner Studio software is the same as manual calculations.

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