University Student Satisfaction Analysis on Academic Services by Using Decision Tree C4.5 Algorithm (Case Study: Universitas Putra Indonesia “YPTK” Padang)

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Abstract. Satisfaction is a dynamic process which can affect many things. Satisfaction can be achieved from many aspects. In higher education, student as a main customer and consumer of the university which has big role in growth of the university needs to be satisfied. Student satisfaction will have an impact to the sustainability of the university. Where satisfaction generally gotten from the services given by the university. This research focus on academic services by the university. Attributes of service quality such as tangibles, reliability, responsiveness, assurance, empathy and information system (as a new additional attribute which is rarely analyzed) are used to measure student satisfaction level. Data has been collected by distributing questionnaires to 100 UPI YPTK Padang students and then processed with decision tree c4.5 algorithm. The result revealed 82 students were satisfied and the remaining 18 students were dissatisfied. Moreover, 95% accuracy algorithm is obtained and categorized as very good classification.

1. Introduction
The world of education faces very difficult challenges due to rapid development of the era. There is very competitive competition in gathering students as a result of very large number of educational institutions [1, 2]. Thus, every educational institution must be able to compete and trying to be superior in the competition. Higher education institutions must take anticipatory steps to deal with the competition and are responsible for evaluating and improving all aspects of the services they have, including in terms of academic services. Academic service can be interpreted as an effort carried out by university to provide convenience in fulfilling the needs of students in matters relating to academic activities [2].

Teaching quality (academic) is the key factor on student satisfaction [3], [4] and administrative services should not be considered as trivial things if university want to increase student satisfaction [2], [5], [6]. Dissatisfaction can make the student to stop continuing the learning program or to even move to the other university. So that, management of university must concerns about understanding and handling student satisfaction [6].

Data mining is also called as a series of processes to explore added value in the form of knowledge that has not known manually from a collection data [7]–[13]. Data mining is often referred to as knowledge discovery in database (KDD). KDD is an activity which includes collection, data usage, historically to find order, pattern or relationship in the data set large size [14], [15]. Data mining is a technique of digging valuable information hidden or hidden in a very large data collection so that an interesting pattern that was previously unknown is found [16], [17].
C4.5 is the most widely used method of algorithm for producing decision trees [13], [18], [19] and in analyzing data about education and decision trees also applied because it can help researchers better in interpreting data information obtained [11], [12], [17], [20]. C4.5 algorithm can predict data accuracy with the best results [21]–[24]. In general the C4.5 algorithm for building a decision tree is as following [25]–[27]:
1. Select the attribute as root.
2. Create a branch for each value.
3. Share cases in branches.
4. Repeat the process for each branches up to all cases on the branch have the same class.

The decision tree is useful for classifying data [13], [18], [19]. Decision tree does not use distance vector to classify objects. Often observation data has attributes nominal value. For example the object is a collection of fruits can be distinguished based on form attributes, color, size and taste. The shape, color, size and taste are nominal quantities, which are of a nature categorically and each value cannot be added together or deductible. There are color attributes some possible values namely green, yellow, red. In the size attribute there is a value big, medium and small. With values this attribute, then a decision tree is made for determine an object including the type of fruit what if the value of each attribute is given [14]. With this decision tree, it can facilitate institutions in making decisions [25]. The concept of a decision tree is to convert data into decision trees and decision rules [27].

![Figure 1. The concept of Decision Tree](image)

Here are some studies that use the c4.5 algorithm in analyzing satisfaction.

| No. | Author(s) and Year | Technique(s) | Tool(s) | Topic Focus |
|-----|-------------------|--------------|---------|-------------|
| 1   | Wiers-Jenssen et al. 2002 [3] | Questionnaire | SPSS | Student satisfaction |
| 2   | Cotton et al. 2002 [28] | Questionnaire | SEM, Lisrel 8 | Satisfaction, well being and performance |
| 3   | Kara and DeShields. 2004 [29] | Questionnaire | SPSS | Student satisfaction, intention and retention |
| 4   | Kao. 2007 [6] | Questionnaire, survey | SPSS | University student satisfaction |
| 5   | Dejeager et al. 2012 [1] | Data mining | - | Student satisfaction |
| 6   | Ravindran and Kalpana. 2012 [30] | Questionnaire, survey | SPSS | Student's Expectation, Perception and Satisfaction |
| 7   | Jiewanto et al. 2012 [31] | Questionnaire, survey | SEM, SPSS 16, and AMOS 16 | Service quality to WOM Intention |
| 8   | Temizer and Turkyilmaz. 2012 [32] | Questionnaire, survey | SEM PLS | Student satisfaction index |
| 9   | Horstschräer. 2012 [33] | Questionnaire, survey | SPSS | University rankings |
| 10  | Jindal and Borah. 2013 [34] | EDM | Literature review | Survey on EDM |
| 11  | Khosravi et al. 2013 [35] | Questionnaire, Kaiser | | Student |
|   | Authors           | Method         | Tool   | Objective                                                                 |
|---|------------------|----------------|--------|---------------------------------------------------------------------------|
| 12| Kaur et al. 2013 [36] | Survey, Data mining | Normalization, Descriptive statistic | Satisfaction, Questionnaire of student satisfaction |
| 13| Mandala. 2013 [25] | Decision Tree, c4.5 algorithm | Estard Data Miner | Prediction of credit risk Student satisfaction |
| 14| Shi et al. 2014 [37] | Questionnaire, survey | Minitab 16 | Student satisfaction Customer satisfaction |
| 15| Tama. 2015 [38] | C4.5, REANN | Java based | Student satisfaction from National Student Survey (NSS) |
| 16| Lenton. 2015 [39] | Questionnaire, survey | Hefce, Hesa, Ons | Student satisfaction, achievement and absorption capacity |
| 17| El-Hilali et al. 2015 [40] | Questionnaire, survey | SPSS | Service quality to customer loyalty Welfare Services |
| 18| Iskandar et al. 2016 [41] | Questionnaire | SPSS | |
| 19| Motefakker. 2016 [42] | Questionnaire, survey | SPSS | |
| 20| Oktafianto. 2016 [2] | Decision tree, c4.5 algorithm | RapidMiner | Academic services Student satisfaction |
| 21| Reina. 2016 [5] | Questionnaire, survey | SPSS | |
| 22| Sudrajat et al. 2017 [18] | C4.5, ID3, decision tree | Matlab | Data mining classification Student satisfaction literature review |
| 23| Weerasinghe et al. 2017 [43] | Data collection | Literature review | |
| 24| Yuliana et al. 2017 [44] | C4.5 algorithm, Decision tree | RapidMiner | Student satisfaction to lecturer performance Exploratory research |
| 25| Castro et al. 2017 [17] | Data collection | Descriptive statistic | Service quality to customer loyalty |
| 26| Rahma. 2017 [45] | Questionnaire, survey | SPSS | Prediction of final school exam grades |
| 27| Aldi. 2017 [46] | Neural Network, Backpropagation | Matlab | Customer satisfaction |
| 28| Shiddiq et al. 2018 [24] | Decision Tree, c4.5 algorithm | Borland Delphi 7.0 | Student academic evaluation Customer satisfaction |
| 29| Budiman et al. 2018 [47] | Decision Tree, c4.5 algorithm | WEKA | |
| 30| Tsami et al. 2018 [26] | Decision Tree, j48 algorithm | WEKA | |
| 31| Ridho et al. 2018 [48] | K-Means algorithm | Dreamweaver, Xampp | Student satisfaction to learning process |
From literature above, data mining was dominantly used to predict student satisfaction. By using decision tree C4.5 algorithm, expected to be able to know student satisfaction level and to know the most dominant dimensions of service quality that affect the quality of services given by the university, to help university management on analyzing and evaluating the services. So that, it can be used as a model for decision making.

2. Methodology
This study uses the results of questionnaires distributed to respondents in this case are students as primary data processed with Rapidminer software that produces a decision tree. Data processing stages are described in Figure 2.

![Figure 2. Data processing stages](image)

2.1. Data Collection
In this study data collection was done by distributing questionnaires to students. The questionnaire was distributed to 100 YPTK Padang UPI students. The attributes in this questionnaire are factors that influence student satisfaction such as tangibles, reliability, responsiveness, assurance, empathy and information system. Questionnaire is described in Figure 3.
2.2. Preliminary data processing

The initial data is processed using Microsoft Excel, where every aspect of the assessment of academic services has several points, which then get an average value from each aspect.

Figure 3. Items of questions on questionnaire

This questionnaire consisted of 40 items of questions using 5 values from the Likert scale namely 1 was “not satisfied”, 2 was “less satisfied”, 3 was “quite satisfied”, 4 was “satisfied” and 5 was “very satisfied”.

Figure 4. Preliminary data
2.3. Proposed model

The model proposed in this study is to use the c4.5 algorithm. Where C4.5 algorithm is used to convert data into decision trees, which later can produce the desired rules.

2.4. Test of C4.5 algorithm model

Testing is done using RapidMiner software by importing data in the form of excell, then tested with a decision tree model. So that it produces the decision tree and the rules.

2.5. Evaluation and validation of C4.5 algorithm model

Evaluation and validation of the tests that have been done is by using confusion matrix. Look for True Negative (TN), False Positive (FP), False Negative (FN), and True Positive (TP) values from the rule results, then find accuracy, precision and recall. And finally get the level of accuracy then categorize the results of the accuracy

3. Result and Discussion

The results of processing 100 data using RapidMiner Software such as Figure 6.

Figure 6. Student satisfaction meta data

From figure 6, there are numbers that show Student satisfaction as many as 82 people, and not satisfied as many as 18 people. From the data in figure 6, a Decision Tree can be generated like Figure 7 below.
Then it can be concluded that the Satisfied and Dissatisfied Rules based on the Decision Tree in Figure 7 are as follows:

**RULES YES (SATISFIED)**
Rule 1: IF Assurance > 3.100 AND Tangibles > 3.188 AND Reliability > 2.611 AND Tangible > 3.438
THEN Result = YES
Rule 2: IF Assurance > 3.100 AND Tangibles > 3.188 AND Reliability > 2.611 AND Tangible ≤ 3.438
AND Responsiveness > 2.917 THEN Result = YES
Rule 3: IF Assurance ≤ 3.100 AND Reliability ≤ 2.278 THEN Result = YES
Rule 4: IF Assurance ≤ 3.100 AND Reliability > 2.278 AND Information System ≤ 3 AND Information System > 2.750 THEN Result = YES

**RULES NO (DISSATISFIED)**
Rule 5: IF Assurance > 3.100 AND Tangibles ≤ 3.188 THEN Result = NO
Rule 6: IF Assurance > 3.100 AND Tangibles > 3.188 AND Reliability ≤ 2.611 THEN Result = NO
Rule 7: IF Assurance > 3.100 AND Tangibles > 3.188 AND Reliability > 2.611 AND Tangibles ≤ 3.438 AND Responsiveness ≤ 2.917 THEN Result = NO
Rule 8: IF Assurance ≤ 3.100 AND Reliability > 2.278 AND Information System > 3 THEN Result = NO
Rule 9: IF Assurance ≤ 3.100 AND Reliability > 2.278 AND Information System ≤ 3 AND Information System ≤ 2.750 THEN Result = NO

From the 9 Rules above, there are 4 Rules for Satisfied Students, and 5 Rules for Dissatisfied Students, so to measure the accuracy of the data for classification using RapidMiner Software, performance measurements can be performed using Confusion Matrix. There are 4 (four) terms as a representation of the results of the classification process. The four terms are True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN). True Negative Value (TN) is the number of negative data detected correctly, while False Positive (FP) is negative data but detected as positive data. Meanwhile, True Positive (TP) is positive data that is detected correctly. False Negative (FN) is the opposite of True Positive, so the data is positive, but it is detected as negative data. Then the results can be obtained as follows:
Table 2. Student Satisfaction

| Amount of data | Error | True Positive (TP) | True Negative (TN) | False Positive (FP) | False Negative (FN) |
|----------------|-------|--------------------|--------------------|---------------------|---------------------|
| 100            | 5     | 79                 | 16                 | 2                   | 3                   |

Table 3. Student Dissatisfaction

| Amount of data | Error | True Positive (TP) | True Negative (TN) | False Positive (FP) | False Negative (FN) |
|----------------|-------|--------------------|--------------------|---------------------|---------------------|
| 100            | 5     | 16                 | 79                 | 3                   | 2                   |

Based on the value of True Negative (TN), False Positive (FP), False Negative (FN), and True Positive (TP) values, Accuracy, Precision, and Recall can be obtained. Accuracy values describe how accurately the system can classify data correctly. In other words, the value of accuracy is a comparison between data that is correctly classified and the overall data. Accuracy values can be obtained by Equation 1. Precision values describe the number of positive category data that are classified correctly divided by the total data classified as positive. Precision can be obtained by Equation 2. Meanwhile, recall shows what percentage of the positive category data is correctly classified by the system. The recall value is obtained by Equation 3.

\[
\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} \times 100\%
\]

\[
\text{Precision} = \frac{TP}{TP + FP} \times 100\%
\]

\[
\text{Recall} = \frac{TP}{TP + FN} \times 100\%
\]

Then from the formula above, the Confusion Matrix value is obtained in table 4.

Table 4. Confusion Matrix

| True Satisfied | True Dissatisfied | Precision |
|----------------|-------------------|-----------|
| Satisfied Prediction | 79           | 16         | 97,53 %   |
| Dissatisfied Prediction | 16          | 79         | 84,21 %   |
| Recall | 96,34 % | 88,88 % |

The value of table 4, Confusion matrix has an accuracy rate of 95%, with the value of precision in the predictions of satisfaction at 97.53% and the precision value of predictions not satisfied at 84.21%. Class recall for satisfaction at 96.34% and class recall for dissatisfaction at 88.88%

From the evaluation results in table 4. shows that the accuracy of the results is 95% or 0.95, so if it is classified in the following classification:

a. 0.90 - 1.00 = very good classification
b. 0.80 - 0.90 = good classification
c. 0.70 - 0.80 = sufficient classification
d. 0.60 - 0.70 = bad classification
e. 0.50 - 0.60 = wrong classification

Then it can be concluded according to the classification grouping into a very good classification for satisfaction data of UPI YPTK Padang Students.

4. Conclusion

Based on the results of this study, it can be concluded that the use of decision tree c4.5 algorithm is very good at accuracy in analyzing student satisfaction with academic services. The accuracy is
categorized as a very good classification. It is hoped that this research will be beneficial for universities in general and UPI YPTK specifically to make decisions in determining ways to increase student satisfaction in the future and also can be a reference for future researchers who process data mining regarding student satisfaction and other types of satisfaction. Furthermore, other researchers can further develop research not only from academic services but also in terms of infrastructure, lecturer performance, university support, etc.

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