Decision Support System for Departemen Selection for Prospective Students using the Naïve Bayes Method and Analytical Hierarchy Process Model at Faculty of Engineering Universitas Musamus

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Abstract. For prospective new students often feel confused in choosing majors to continue their education at the University. The faculty of engineering is one of the favorite faculties for prospective students but sometimes most feel confused choosing what majors are in accordance with their academic abilities, so that the selection of majors often follows the choice of their closest friends or their parents’ choices. The selection of inappropriate majors will affect the future of the prospective new student. For this reason, prospective new students must know their academic abilities and interests. With a decision support system for determining majors, it is hoped that it can help prospective new students to find out the greatest potential of the choice of majors in accordance with their academic abilities and talents. Decision Support Systems made implementing the Naïve Bayes method to find out which prospective new students can potentially enter one of the departments in the technical faculty other than that the use of the Analytic Hierarchy Process model is used to find out the right choice of majors. The Naïve Bayes method refers to the rules for admitting new prospective students, which will obtain the probability formula yes and the probability formula no, to be used in calculations with data samples. The AHP model refers to the value of subjects that are tested or tested on the admission test for prospective new students. Calculations using Naïve Bayes for student data samples for the 2019-2020 school year, using 10 sample data on prospective students, obtained 3 students who did not enter the department of engineering or have no academic potential to enter the department of engineering. While other students who entered were calculated using the AHP Model, and obtained 1 student whose majors were not appropriate. While other students have chosen the right majors according to their academic abilities. In the end this Decision Support System can be used to find out which potential new students are potential and who have no potential and can also provide recommendations for the selection of the right majors in accordance with the academic abilities of prospective new students.

Keywords: Decision Support System; AHP; Naïve Bayes; Prospective Student.

1. Introduction
Continuing higher education is the goal of many students in Indonesia who are currently attending high school. After completing high school, the students certainly want to continue their higher education, which is to enter university. Both state universities and private universities, both domestically and
abroad. The desire to continue higher education and choose majors as desired is the dream of the students [1].

Universitas Musamus has 6 majors in technical faculties namely Civil Engineering (TS), Mechanical Engineering, Electrical Engineering (TE) and Informatics Engineering (IT), Architectural Engineering (TA) and Information Systems (SI). Where the engineering faculty is the most favorite faculty n prospective students. However, most students do not dare to choose the faculty of engineering because prospective students feel confused choosing majors that match their interests and talents[2]. The selection of inappropriate majors will affect the future of the prospective new student. Errors in the selection of majors are usually caused by prestige, prestige, coolness, parents' advice, joining in with friends, or having no other choice. In choosing a major a prospective student should choose a major that suits his abilities both academically and in his talent. The choice in a hurry will result in a late awareness that the majors that are taken are not in accordance with his personality to the worse result of the issuance of a student / student because they are declared unable to attend the education (DO-Drop Out). Selection of majors as early as possible should be considered because mistakes in choosing majors are a disaster and a big loss for prospective new students in the future.

A prospective new student must know their academic abilities, desires / interests and their own talents [3]. The availability of the Decision Support System for the Determination of Student Departments is expected to help prospective new students to find out the greatest potential for admission to the faculty of engineering and choose majors in accordance with their academic abilities, and can also benefit Musamus University, of course, to obtain potential new students academically and later have success in accordance with the choice of majors.

2. Theoretical Review
2.1 Decision Support System

Decision Support System is defined as a computer-based interactive system that can help decision makers use data and models to solve problems that are not structured [4].

2.2 Naïve Bayes

The Naïve Bayes method is a simplified model of the Bayes method used in machine learning. The method is used to obtain a decision-making hypothesis based on the probability value of prior conditions that are known or previously designed The Bayes method is adopted from the name of the discovery, Thomas Bayes, which is often found in statistical studies based on the Bayes rule theorem. The Bayes Method is a probability condition theory that takes into account the probability of an event / hypothesis depending on other events / evidence. Basically, the theorem says that future events can be predicted on condition that previous events have occurred [5].

The basic formula for the Naïve Bayes method uses the Bayes theorem and the Conditional Probability formula. Bayes' theorem can be written in the form:

\[ P(X|Y) = \frac{P(Y | X)}{\sum P(Y | X)} \]  

2.3 Analytical Hierarchy Process (AHP)

This method is a framework for making effective decisions on complex problems by simplifying and speeding up the decision making process by solving the problem into its parts, arranging these parts or variables in a hierarchical arrangement, giving numerical values to subjective considerations of the importance of each variable and synthesize these considerations to determine which variable has the highest priority and act to influence the outcome of the situation [6]. This AHP method helps solve
complex problems by structuring a hierarchy of criteria, interested parties, results and by attracting various considerations to develop weights or priorities. This method also combines the power of feelings and logic involved in various problems, then synthesizes various considerations into results that match the intuitive estimates as presented in the considerations that have been made [7].

Analytical Hierarchy Process (AHP) is one of the methods in the decision making process with its main equipment being a functional hierarchy with human perception input. By using hierarchy, a complex and unstructured problem can be solved in groups. Then the groups are arranged into a hierarchical form [8].

3. Result
3.1 Design using naïve bayes

Determination of admission of prospective new students at Musamus University is used testing the grades obtained by students in several fields of science being tested, the use of the Naïve Bayes method is formulated as follows:

1. The ability of technical calculation seen from Mathematics - Physics subject is Num (x) = {High, Normal, Low}
2. Science ability seen from Chemistry - Biology is Science (x) = {High, Normal, Low}
3. Language skills seen from Indonesian - English subjects are Verb (x) = {High, Normal, Low}
4. Mechanical abilities seen from the subject of Practice and Vocational Engineering are Mec (x) = {High, Normal, Low}

Note: High for values above 70, Normal for the range of values 51 to 69, and Low for values below 50

Table 1. Rules for admission of new students based on the Naïve Bayes Method

| Criteria | NUM  | SAINS | VERB  | MEC  | F E |
|----------|------|-------|-------|------|-----|
| K1       | HIGH | HIGH  | HIGH  | HIGH | Y   |
| K2       | HIGH | HIGH  | LOW   | HIGH | Y   |
| K3       | HIGH | LOW   | HIGH  | HIGH | Y   |
| K4       | NORMAL | NORMAL | HIGH  | HIGH | Y   |
| K5       | NORMAL | HIGH  | NORMAL | HIGH | Y   |
| K6       | NORMAL | NORMAL | LOW   | HIGH | Y   |
| K7       | HIGH  | LOW   | NORMAL | NORMAL | Y   |
| K8       | HIGH  | NORMAL | HIGH  | NORMAL | Y   |
| K9       | HIGH  | HIGH  | NORMAL | NORMAL | Y   |
| K10      | HIGH  | NORMAL | NORMAL | LOW   | Y   |
| K11      | HIGH  | LOW   | LOW   | HIGH  | Y   |
| K12      | NORMAL | NORMAL | NORMAL | NORMAL | Y   |
| K13      | LOW   | NORMAL | NORMAL | NORMAL | N   |
| K14      | NORMAL | NORMAL | NORMAL | LOW   | N   |
| K15      | LOW   | HIGH  | HIGH  | LOW   | N   |
| K16      | LOW   | HIGH  | LOW   | NORMAL | N   |
| K17      | NORMAL | LOW   | HIGH  | LOW   | N   |
| K18      | LOW   | LOW   | NORMAL | NORMAL | N   |
| K19      | LOW   | NORMAL | NORMAL | LOW   | N   |
| K20      | NORMAL | LOW   | NORMAL | LOW   | N   |
| K21      | LOW   | NORMAL | HIGH  | NORMAL | N   |
| K22      | LOW   | LOW   | HIGH  | NORMAL | N   |
| K23      | NORMAL | LOW   | LOW   | LOW   | N   |
| K24      | LOW   | LOW   | LOW   | LOW   | N   |
The results of the development for the Naïve Bayes formula consist of two formulas, namely the formula for the condition or academic value criteria accepted in the Engineering department and the formula for the state or academic value criteria not accepted in the Engineering department, as follows:

1. The formula for criteria for academic grades is accepted at the Engineering faculty:

\[
T(X|Y) = \frac{T(X=Y|Y)}{X} * T(X1=NUM(X)|Y) * T(X2=VERB(X)|Y) * T(X3=SAINS(X)|Y) * T(X4=MEK(X)|Y)
\]  

(2)

2. Formulas for criteria for academic grades not accepted at the engineering faculty:

\[
T(X|N) = \frac{T(X=N|N)}{X} * T(X1=NUM(X)|N) * T(X2=VERB(X)|N) * T(X3=SAINS(X)|N) * T(X4=MEK(X)|N)
\]  

(3)

Based on the two formulas above, two probability conditions can be generated to classify the admission criteria for new students with the Naïve Bayes method, namely:

1. If \( T(X|Y) \geq T(X|N) \), it will produce a condition of academic grade criteria accepted at the faculty of engineering
2. If \( T(X|Y) < T(X|N) \), it will produce a condition of academic value criteria not accepted in the faculty of engineering.

3.1.1 Testing with Student Value Data Samples

Testing can and cannot be accepted at the faculty of engineering using a sample of one of the prospective student scores based on the subject values listed in Table 2.

| VALUE | PHIS | MATH | CHEM | BIO | PRAC | VOC | IND | ENG |
|-------|------|------|------|-----|------|-----|-----|-----|
| 70    | 66   | 71   | 51   | 60  | 80   | 50  | 44  |

Table 3. Converting sample data into the Naïve Bayes method part 1

| VALUE | NUM(X) | VERB(X) | SAINS(X) | MEK(X) |
|-------|--------|---------|----------|--------|
| 68    | 47     | 61      | 70       |

Table 4. Convert sample data into rule form Naïve Bayes Method part 2

| VALUE | NUM(X) | VERB(X) | SAINS(X) | MEK(X) |
|-------|--------|---------|----------|--------|
| NORMAL| RENDAH | NORMAL  | TINGGI   |

3.1.2 Calculation by the Naïve Bayes method:

After getting the conversion that can be seen in Table 4. Then enter the naïve bayes method rule using equation 2 and equation 3

\[
T(X = Y | Y) / X = 12/24
\]

\[
T(X1 = Num (x) | Y) = 4/12
\]

\[
T(X2 = Verb (x) | Y) = 3/12
\]

\[
T(X3 = Science (x) | Y) = 5/12
\]

\[
T(X4 = Mek (x) | Y) = 7/12
\]

\[
T(X | Yes) = 12/24 * 4/12 * 3/12 * 5/12 * 7/12 = 0.0098
\]
\[ T(\text{X} = \text{N} | \text{N}) / \text{X} = 12/24 \]
\[ T(\text{X}_1 = \text{Num}(x) | \text{N}) = 4/12 \]
\[ T(\text{X}_2 = \text{Verb}(x) | \text{N}) = 3/12 \]
\[ T(\text{X}_3 = \text{Science}(x) | \text{N}) = 4/12 \]
\[ T(\text{X}_4 = \text{Mek}(x) | \text{N}) = 0/12 \]
\[ T(\text{X} | \text{No}) = 12/24 \times 4/12 \times 3/12 \times 4/12 \times 0/12 = 0 \]

In order to obtain \( T(\text{X} | Y) > T(\text{X} | \text{N}) \), which means that prospective students are accepted. Calculations using Naïve Bayes for student data samples for the 2019-2020 school year, using 10 sample data prospective students obtained 3 students who did not enter the department of engineering or have no academic potential to enter the department of engineering.

3.2 Design using AHP

The design using the AHP method uses a priority comparison matrix on each subject value that can be seen in Table 5.

| M1 | CHEM | BIO | PHIS | MATH | ENG | IND | PRAC | VOC | TOTAL PRIORITY |
|----|------|-----|------|------|-----|-----|------|-----|----------------|
| CHEM | 0.06 | 0.11 | 0.03 | 0.11 | 0.07 | 0.04 | 0.11 | 0.11 | 0.63 | 0.08 |
| BIO | 0.02 | 0.04 | 0.02 | 0.04 | 0.05 | 0.03 | 0.04 | 0.04 | 0.26 | 0.03 |
| PHIS | 0.17 | 0.18 | 0.10 | 0.18 | 0.09 | 0.07 | 0.18 | 0.18 | 1.15 | 0.14 |
| MAT | 0.02 | 0.04 | 0.02 | 0.04 | 0.05 | 0.03 | 0.04 | 0.04 | 0.26 | 0.03 |
| ENG | 0.40 | 0.32 | 0.49 | 0.32 | 0.47 | 0.59 | 0.32 | 0.32 | 3.24 | 0.41 |
| IND | 0.29 | 0.25 | 0.30 | 0.25 | 0.16 | 0.20 | 0.25 | 0.25 | 1.94 | 0.24 |
| PRAC | 0.02 | 0.04 | 0.02 | 0.04 | 0.05 | 0.03 | 0.04 | 0.04 | 0.26 | 0.03 |
| VOC | 0.02 | 0.04 | 0.02 | 0.04 | 0.05 | 0.03 | 0.04 | 0.04 | 0.26 | 0.03 |
| TOTAL | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 1 |

After obtaining the average priority vector, the priority vector comparison of subjects per department is shown in Table 6.

| AVERAGE AVIATION PRIORITY VECTOR | CHEM | BIO | PHIS | MATH | ENG | IND | PRAC | VOC |
|---------------------------------|------|-----|------|------|-----|-----|------|-----|
| SI | 0.14 | 0.05 | 0.05 | 0.21 | 0.68 | 0.4 | 0.05 | 0.05 |
| TI | 0.12 | 0.05 | 0.04 | 0.22 | 0.63 | 0.36 | 0.05 | 0.05 |
| TE | 0.14 | 0.05 | 0.06 | 0.26 | 0.82 | 0.48 | 0.05 | 0.05 |
| TM | 0.12 | 0.05 | 0.04 | 0.25 | 0.82 | 0.48 | 0.05 | 0.05 |
| TA | 0.14 | 0.05 | 0.06 | 0.23 | 0.74 | 0.43 | 0.06 | 0.06 |
| TS | 0.14 | 0.05 | 0.06 | 0.25 | 0.76 | 0.44 | 0.05 | 0.05 |

Then to calculate the weight of the majors: Department of SI= \([\text{Chem}(\text{M1}) \times \text{SI} | \text{Chem}(\text{M2})] + [\text{Bio}(\text{M1}) \times \text{SI} | \text{Bio}(\text{M3})] + [\text{Phis}(\text{M1}) \times \text{SI} | \text{Phis}(\text{M4})] + [\text{Math}(\text{M1}) \times \text{SI} | \text{Math}(\text{M5})] + [\text{Eng}(\text{M1}) \times \text{SI} | \text{Eng}(\text{M6})] + [\text{Ind}(\text{M1}) \times \text{SI} | \text{Ind}(\text{M7})] + [\text{Prac}(\text{M1}) \times \text{SI} | \text{Prac}(\text{M8})] + [\text{Voc}(\text{M1}) \times \text{SI} | \text{Voc}(\text{M9})]\). In the same way for other majors obtained can be seen in Table 7.
Based on the above table, it can be concluded for the academic data of Student-1, the percentage of the choice of majors, the student entered the Electrical Engineering department by 48%. While other students who entered were calculated using the AHP Model, and obtained 1 student whose majors were incorrect. While other students have chosen the right majors according to their academic abilities.

4. Conclusions

Decision Support System for Student Majors Selection can provide information about potential / non-potential students in engineering majors, the right / incorrect student choosing a major and how much positive / negative interest in selecting student majors. This information can be used as consideration for further coaching to students who have no potential but who have high interest. By using naïve bayes, it can filter student data input in the selection of majors which will then be processed using the AHP (Analytic Hierarchy Process) model and AHP method can assist in the selection of existing student majors at the faculty of engineering.

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