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## Decision support system to choose private higher education based on marketing mix model criteria in Indonesia

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**Abstract.** The growth of the number of universities in Indonesia in the last few years has experienced very rapid progress. Kemenristekdikti data for 2017 is 3,276 universities (3,154 PTS and 122 PTN) in Indonesia with 555 university details (17.6%), 78 institutes (2.5%), 1,431 Sekolah Tinggi (45.4%), 1,022 Academy (32.4 %) and Polytechnic 190 (6.0%). A large number of private universities (PTS) in Indonesia is very influential for prospective students in taking the decision to choose a college to continue their studies. Decision Support Systems are popular tools that help decision making within an organization [1]. Criteria Decision Making (MCDM), namely AHP (Analytic Hierarchy Process). AHP is quite effective in simplifying and speeding up the decision making the process by solving the problem into its parts [2]. Multi-Criteria Decision Making (MCDM) and Analytic Hierarchy Process can be applied in various fields. According to [3], marketing mix (Place, Product, Promotion, Price, People, Process and Physical Evidence) simultaneously influences the decision to elect private universities in Indonesia. Based on data processing and analysis that has been carried out in the previous section, it can be concluded that the chosen college is college a based on the criteria of place, price, product, people, promotion, process and physical evidence with a value of 0.379.

### 1. Introduction

The growth the number of tertiary institutions in Indonesia in recent years has experienced very of rapid progress. According to Kemenristekdikti for 2017 is 3,276 universities (3,154 PTS and 122 PTN) in Indonesia with 555 university details (17.6%), 78 institutes (2.5%), 1,431 sekolah tinggi (45.4%), 1,022 academy (32.4%) and Polytechnic 190 (6.0%).

A large number of private universities (PTS) in Indonesia is very influential for prospective students in taking the decision to choose a college to continue their studies. In addition to the large numbers, the heterogeneity of PTS also became more complex, making it very difficult to choose PTS to get the best education.

Decision Support Systems are popular tools that help decision making within an organization [1]. The process of selecting a college is a problem that involves many components or criteria that are assessed (multi criteria) so that in its completion a decision support system with multi criteria is needed.



One method in the Multi-Criteria Decision Making (MCDM) is AHP (Analytic Hierarchy Process). AHP is quite effective in simplifying and speeding up the decision making the process by solving the problem into its parts [2]. Multi-Criteria Decision Making (MCDM) and Analytic Hierarchy Process can be applied in various fields.

One of the criteria in choosing private universities is the dimensions in the model marketing mix. According to [3], marketing mix simultaneously affects the decision to elect private universities in Indonesia.

Therefore, this research will be made a decision support system model for university selection with the method Multi-Criteria Decision Making (MCDM) and Analytic Hierarchy Process in Indonesia.

## **2. Method and Material**

### **2.1 Decision support systems Decision support**

Systems are a set of model-based procedures for processing data and assessments to help managers make decisions [4]. According to [5] decision support systems are an approach to support decision making. Decision support systems use data, provide an easy user interface, and can combine decision makers' thoughts.

### **2. 2. Analytic Hierarchy Process (AHP)**

AHP is a method that can help decision-makers to find one of the best in accordance with their goals and understanding of the problem of selection faced. The first AHP model developed by Thomas L. Saaty [6] are AHP with weighting additive. Called additives because arithmetic operations to get the total weight in addition. In the AHP method, there are three main principles that must be considered, namely [6] :

1. Principles for the preparation of hierarchies
2. The principle of determining priorities
3. The principle of logical consistency

According to [7], the Multi-Criteria Decision Making (MCDM) relates to the selection of choices optimal between alternatives based on attributes or decision criteria. Multi criteria problems are simplified in the form of a hierarchy consisting of 3 main components. That is the goal or goal of decision making, assessment criteria, and alternative choices.

AHP steps:

1. Define the problem and determine the desired solution.  
This stage determines the problems that we will solve clearly, determining solutions that might be suitable for solving problems. Solutions may amount to more than one that we will develop further in the next stage.
2. Create a hierarchical structure that begins with the main goal.  
The main goal is the top level in the hierarchy and then followed by the hierarchy level below it, all the criteria that are suitable for making an assessment of alternatives.
3. Create a paired comparison matrix that describes the relative contribution or influence of each element on the objectives or criteria above it.
4. Defines pairwise comparisons so that the total number of judgments can be obtained as many

as  $t = nx [(n-1) / 2]$  pieces, where  $n$  is the number of elements compared.

5. Repeat steps 3 and 4 for all levels of the hierarchy.
6. Calculates the eigenvector of each pairwise comparison matrix.  
The eigenvector is the weight of each element that is used to prioritize elements at the lowest hierarchy level until it reaches the goal, namely at the top level (one element)
7. Checking consistency  
Expected consistency is near perfect to produce decisions that are close to valid. Although it is difficult to achieve perfect, the expected consistency ratio is less than or equal to 0.1.

How to calculate the consistency of

7.1 Menghitung Indeks Konsistensi (CI) dengan rumus:

$$CI = \frac{\lambda_{\max} - n}{n-1}$$

7.2 Menghitung Rasio Konsistensi (CR) dengan rumus:

$$CR = CI/RI$$

### 2.3 Determination of Criteria

Identification criteria in the selection of these private universities, based on the dimensions marketing mix. According to [8], Marketing Mix is a set of marketing tools that are integrated by the company to produce the desired response of the target market. The dimensions of marketing mix [8] is:

- a. Place is a place where private colleges are located.
- b. Product is all departments and study programs in private universities.
- c. Promotion is all efforts made by private universities to introduce their products to the market.
- d. Price is the amount paid by students for education costs and living expenses
- e. People, are people who are directly involved in carrying out all the activities of private universities and are factors that play an important role in the organization.
- f. Physical Evidence is real/physical, such as buildings, equipment, and college facilities.
- g. Process is an attempt by private universities to run and carry out their activities to meet the needs and desires of consumers quickly and accurately.

The hierarchical structure of this research is as shown in Figure 1.

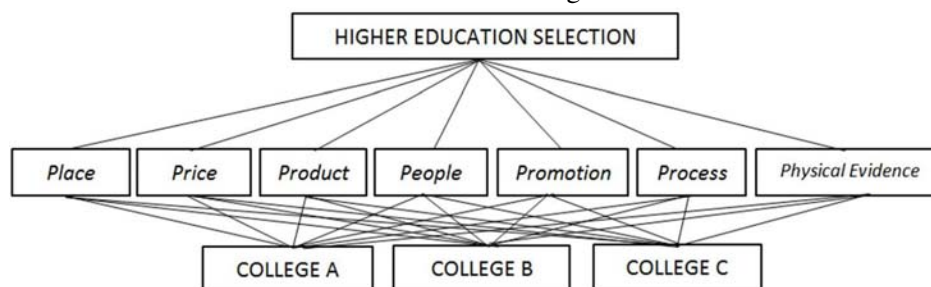


Figure 1. Hierarchy structure of research

### 3. Result and Discussion

Conducted pairwise comparison for each criterion and alternative that is comparing each element with other elements to obtain the level of element importance in the form of qualitative opinions. Pairwise comparisons are made by decision makers.

Relative comparison values are then processed according to the AHP steps to determine the relative rank of all alternatives. Based on the results of these calculations are obtained to produce ranking and priority as in the following tables;

Table 1. Inter Criteria Pairwise Comparison

| Criteria          | Place | Price | Product | People | Promotion | Process | Physical Evidence |
|-------------------|-------|-------|---------|--------|-----------|---------|-------------------|
| Place             | 1,00  | 0,33  | 2,00    | 2,00   | 1,00      | 2,00    | 2,00              |
| Price             | 3,00  | 1,00  | 2,00    | 2,00   | 2,00      | 1,00    | 1,00              |
| Product           | 0,50  | 0,50  | 1,00    | 2,00   | 0,50      | 2,00    | 0,50              |
| People            | 0,50  | 0,50  | 0,50    | 1,00   | 0,33      | 2,00    | 2,00              |
| Promotion         | 1,00  | 0,50  | 2,00    | 3,00   | 1,00      | 2,00    | 0,50              |
| Process           | 0,50  | 1,00  | 0,50    | 0,50   | 0,50      | 1,00    | 2,00              |
| Physical Evidence | 0,50  | 1,00  | 2,00    | 0,50   | 2,00      | 0,50    | 1,00              |
| Total             | 7,00  | 4,83  | 10,00   | 11,00  | 7,33      | 10,50   | 9,00              |

The first step is to normalize each column by dividing each value in column i and row j with the total value in column i.

Table 2. Normalization

| Criteria          | Place | Price | Product | People | Promotion | Process | Physical Evidence | Total | Priority vector |
|-------------------|-------|-------|---------|--------|-----------|---------|-------------------|-------|-----------------|
| Place             | 0,14  | 0,07  | 0,20    | 0,18   | 0,14      | 0,19    | 0,22              | 1,14  | 0,16            |
| Price             | 0,43  | 0,21  | 0,20    | 0,18   | 0,27      | 0,10    | 0,11              | 1,50  | 0,21            |
| Product           | 0,07  | 0,10  | 0,10    | 0,18   | 0,07      | 0,19    | 0,06              | 0,77  | 0,11            |
| People            | 0,07  | 0,10  | 0,05    | 0,09   | 0,05      | 0,19    | 0,22              | 0,77  | 0,11            |
| Promotion         | 0,14  | 0,10  | 0,20    | 0,27   | 0,14      | 0,19    | 0,06              | 1,10  | 0,16            |
| Process           | 0,07  | 0,21  | 0,05    | 0,05   | 0,07      | 0,10    | 0,22              | 0,76  | 0,11            |
| Physical Evidence | 0,07  | 0,21  | 0,20    | 0,05   | 0,27      | 0,05    | 0,11              | 0,96  | 0,14            |
| Total             | 1,00  | 1,00  | 1,00    | 1,00   | 1,00      | 1,00    | 1,00              | 7,00  | 1,00            |

Table 3. Normalization Criteria

| COLLEGE   | PRIORITY VEKTOR |       |         |        |           |         |                   |
|-----------|-----------------|-------|---------|--------|-----------|---------|-------------------|
|           | Place           | Price | Product | People | Promotion | Process | Physical Evidence |
| COLLEGE A | 0,16            | 0,13  | 0,52    | 0,54   | 0,52      | 0,57    | 0,46              |
| COLLEGE B | 0,30            | 0,28  | 0,33    | 0,30   | 0,33      | 0,29    | 0,42              |
| COLLEGE C | 0,54            | 0,59  | 0,14    | 0,16   | 0,14      | 0,14    | 0,13              |
| TOTAL     | 1,00            | 1,00  | 1,00    | 1,00   | 1,00      | 1,00    | 1,00              |

After normalizing, the next step is to determine priority weights on each criterion, and obtained Eigenvalues as in table 4

Table 4. Eigen Value

| Criteria                 | Eigen Value |
|--------------------------|-------------|
| <i>Place</i>             | 1,323       |
| <i>Price</i>             | 1,705       |
| <i>Product</i>           | 0,884       |
| <i>People</i>            | 0,760       |
| <i>Promotion</i>         | 1,265       |
| <i>Process</i>           | 0,866       |
| <i>Physical Evidence</i> | 1,076       |

Table 5. Eigen Value Criteria

| COLLEGE   | EIGEN VALUE  |              |                |               |                  |                |                          |
|-----------|--------------|--------------|----------------|---------------|------------------|----------------|--------------------------|
|           | <i>Place</i> | <i>Price</i> | <i>Product</i> | <i>People</i> | <i>Promotion</i> | <i>Process</i> | <i>Physical Evidence</i> |
| COLLEGE A | 0,49         | 0,47         | 0,74           | 0,74          | 0,74             | 0,76           | 0,71                     |
| COLLEGE B | 1,04         | 0,97         | 1,17           | 1,04          | 1,17             | 1,00           | 1,46                     |
| COLLEGE C | 1,62         | 1,53         | 2,38           | 2,38          | 2,38             | 2,43           | 2,33                     |

$$\lambda = \frac{(\sum \text{EigenValue/PriorityVektor})}{N}$$

$$\lambda = \frac{((1,323/0,16)+(1,705/0,21)+(0,884/0,11)+(0,760/0,11)+(1,265/0,16)+(0,866/0,11)+(1,076/0,14))}{7}$$

$$\lambda = \frac{54,81}{7} = 7,83$$

Next,

$$\text{CI (Consistensi Index)} = \frac{\lambda - n}{n-1} = 0,14$$

$$\text{CR (Consistensi Ratio)} = \frac{\text{CI}}{\text{RI}} = 0,099$$

Because the result of  $\text{CR} \leq 0.1$ , consistent assessment and data processing can proceed to the next calculation. Based on the AHP calculation, the final ranking results are obtained as follows:

Table 6. Priority Ranking Value

|           | <i>Place</i> | <i>Price</i> | <i>Product</i> | <i>People</i> | <i>Promotion</i> | <i>Process</i> | <i>Physical Evidence</i> | <i>PRIORITY RANKING</i> |
|-----------|--------------|--------------|----------------|---------------|------------------|----------------|--------------------------|-------------------------|
|           | 0,16         | 0,21         | 0,11           | 0,11          | 0,16             | 0,11           | 0,14                     |                         |
| COLLEGE A | 0,16         | 0,13         | 0,52           | 0,54          | 0,52             | 0,57           | 0,46                     | 0,379                   |
| COLLEGE B | 0,30         | 0,28         | 0,33           | 0,30          | 0,33             | 0,29           | 0,42                     | 0,318                   |
| COLLEGE C | 0,54         | 0,59         | 0,14           | 0,16          | 0,14             | 0,14           | 0,13                     | 0,304                   |

Based on Table 6 shows that college A has the highest score of 0.379, followed by college B with a value of 0.318 and finally college C with a value of 0.304. The results of calculating the value of each

college show that there is no significant difference in value between colleges because the assessment given by decision makers is subjective.

#### 4. Conclusion

Based on the data processing and analysis that has been carried out in the previous section it can be concluded that the chosen college is college A based on the criteria of place, price, product, people, promotion, process and physical evidence with a value of 0.379.

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