Application of Topsis Method in Decision Support System
Selection of Undergraduate Scholarship Recipients

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ABSTRACT

The procurement of scholarship programs is one of the efforts made by the government, companies, or foundations to help individuals for the ongoing education that is being pursued, one of which is in the world of education such as STMIK Pelita Nusantara, where the campus is under the auspices of the Democrat Cemerlang Foundation, a foundation that participate in the provision of scholarship programs, both underprivileged scholarships and merit scholarships. In granting scholarships, many things must be considered so that the right decisions are made, namely the best students who meet the requirements and criteria that have been set and are not subjective. so far the campus is experiencing difficulties because there are many students who graduate each year while there are many conditions that must be considered, so faster, more precise and accurate steps are needed to help the campus determine students who are eligible to receive the scholarship. In this study, the TOPSIS method will be applied to select undergraduate scholarship recipients. The method was chosen because TOPSIS is a method whose basic concept is that the best alternative is the alternative that has the closest distance from the positive ideal solution and has the farthest distance from the negative ideal solution from the point of view geometrically using Euclidian distance to determine the relative proximity of an alternative to the optimal solution. The results obtained in this study are that the TOPSIS method using 5 criteria can be applied in the selection of undergraduate scholarship recipients, where 2 out of 5 alternatives have the highest score of 0.657659 as well as scholarship recipients.

Keywords: Scholarship; TOPSIS; Decision Support System.

1. INTRODUCTION

In order to improve the quality of the nation's generation, various efforts have been made by certain parties to help individuals for the sake of continuing education that is being pursued (Hamadeh, 2019). One of the efforts made is the provision of a program for providing undergraduate scholarships to outstanding students, which can be provided by the government, companies, or foundations (Subagio...
et al., 2017). This program aims to ease the economic burden of students in pursuing higher education in accordance with the study program taken (Jacob et al., 2018), (Gómez-Zapata et al., 2021).

Along with this, (Wu et al., 2019) the development of science and technology (Science and Technology) is growing rapidly at any time, especially in the field of computers which have a major influence on various aspects of human life, one of which is in the world of education such as STMIK Pelita Nusantara where the campus is one of the campuses located in Indonesia. Medan city, North Sumatra Province, which is under the auspices of the Brilliant Democratic Foundation. The foundation is also a foundation that always participates in providing scholarship programs to improve the quality of the nation’s generation by providing various scholarships for both underprivileged and outstanding students. STMIK Pelita Nusantara is certainly required to take more actual steps in utilizing the existence of technology for the smooth running of all activities in the campus environment. These activities include information systems, student affairs, administration, finance, and so on (Abualoush et al., 2018). However, what is discussed in this study is the implementation of the strata-2 scholarship program from foundation for outstanding students.

In granting scholarships, many things must be considered so that the decisions taken are the right decisions, namely the best students who meet the requirements and criteria that have been set and are not subjective (Utami & RUSKAN, 2020), (Skakni, 2018). So far pThe campus is experiencing difficulties because there are many students who graduate each year while there are many conditions that must be considered, so faster, more precise and accurate steps are needed to help the campus determine students who are eligible to receive the scholarship (Collier et al., 2019). One of the technologies that can solve the problem of the scholarship program is DSS (Decision Support System), Decision Support System is an information system based on computer which combines decision models, databases to solve structured or semi-structured problems in the decision-making process by certain managers, so that the results of decisions taken are more accurate and precise (ABEBE, 2021) (Egede-Nissen, 2018). DSS can be solved by various methods, for example by Weight Product, Analytical Hierarchy Process, SAW, TOPSIS and so forth (Handayani, 2017).

Based on the above description in order to obtain the formulation of the problem in this study, namely how to select students who deserve to receive a Strata-2 scholarship by applying the TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution) on DSS for the Selection of Undergraduate Scholarship Recipients?. The problem limitation of this research is a system designed specifically for STMIK Pelita Nusantara, the author only discusses the undergraduate scholarship from the foundation, the system is built using the PHP programming language and the database is MySQL. The purpose of this study is to build a DSS for the selection of undergraduate scholarship recipients on the STMIK Pelita Nusantara campus by applying the TOPSIS method which is expected to help the campus in making the right decisions to determine students who deserve the scholarship.

2. RESEARCH METHOD

2.1 Data collection

In this study, two types of data are needed, namely primary data and secondary data. In the data collection stage in this study, it was carried out in two ways (Corrado et al., 2019), (Aliyyah et al., 2020), namely:

a) Literature Studies (Secondary Data) are obtained from reading or studying books related to the research title and other literatures that support the implementation of the research.

b) Field Study (Primary Data) is an activity to observe directly to the object of research to obtain information about data related to the object of research.

2.2 TOPSIS method analysis

The following are the six stages in the TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution) according to (Erlinda, Murni, & Asaziduhu, 2018), (Chmielarz & Zborowski, 2018), (Radomska-Zalas et al., 2019), (Just & Łuczak, 2019), (Chen et al., 2018):
a) Build a normalized decision matrix. The $rij$ element is the result of the normalization of the decision matrix $R$ using the Euclidean length of a vector method:

$$rij = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

where $i = 1, 2, ..., m$; and $j = 1, 2, ..., n$

b) Construct a weighted normalized decision matrix with weights $W$ - ($w_1, w_2, ..., wn$) $vij = wi * rij$

c) Determine the positive ideal solution and the negative ideal solution. The positive ideal solution is denoted by $A^+$ and the negative ideal solution by $A^-$ is as follows:

$$A^+ = \{(\max_{v_{ij}}) (\min_{v_{ij}} | j \in J)|\}
\{v_{1m}, v_{2m}, ..., v_{nm}\}
$$

$$A^- = \{(\max_{v_{ij}}) (\min_{v_{ij}} | j \in J)|\}
\{v_{1m}, v_{2m}, ..., v_{nm}\}
$$

Where: $v_{ij}$ = matrix element $v$th row $i$th column $j$.

d) Calculating this Separation Measure is a measurement of the distance from an alternative to a positive ideal solution and a negative ideal solution. The distance between alternative $Ai$ and the positive ideal solution is formulated as:

$$S_{i}^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{ij}^+)^2}$$

with $i = 1, 2, ..., m$ (5) The distance between alternative $Ai$ and the negative ideal solution is formulated as:

$$S_{i}^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{ij}^-)^2}$$

with $i = 1, 2, ..., m$

e) Calculates relative closeness to the ideal solution. The relative closeness of alternative $A^+$ to the ideal solution $A^-$ is represented by.

$$C_i = \frac{S_i^-}{S_i^- + S_i^+}$$

with $0 < Ci+ < 1$ and $i = 1, 2, 3, ... m$

6. Alternative ranking. Alternatives can be ranked in order of $C_i$. The alternative with the largest $Ci+$ value is the best solution.

3. RESULTS AND DISCUSSIONS

3.1. Results
The criteria that must be considered and data collected are as follows:

a) Grade Point Average (GPA) = 30%
b) Career achievements in organizations and/or student affairs = 20%
c) Discipline = 20%
d) Publication of Scientific Work = 15%
e) Superior achievement/achievement with weight = 15%

| GPA | Weight |
|-----|--------|
| 3, 30 | 1 |

Table 1. Table of GPA Sub Criteria
After applying the Topsis method in determining the best alternative final score in the selection of scholarship recipients using data from 5 (five) students who were used as samples, the following results were obtained

| Alternative | GPA | Organization | UMH date       | Publication                                         | Achievement |
|-------------|-----|--------------|----------------|----------------------------------------------------|-------------|
| A           | 3.90| BEM, Choir,  | 29/08/2020     | LOA                                               | -           |
| B           | 3.78| BEM, Choir,  | 05/09/2020     | LOA                                               | -           |
| C           | 3.73| BEM          | 05/09/2020     | https://ejournal.sisfokomtek.org/index.php/jikom/article/view/106 | -           |
| D           | 3.70| BEM, Choir,  | 29/08/2020     | https://medikom.ioespublishers.org/index.php/JTI/article/view/31/24 | Copyright   |
| E           | 3.69| BEM, Choir,  | 29/08/2020     | https://medikom.ioespublishers.org/index.php/JTI/article/view/33 | Copyright   |
Table 7. Student Data Table

| Alternative | GPA | Organization | UMH date | Publication | Achievement |
|-------------|-----|--------------|----------|-------------|-------------|
| A           | 3.90 | Number of Followed 2 | Stage 2 | LOA | - |
| B           | 3.78 | Number of Followed 2 | Stage 3 | LOA | - |
| C           | 3.73 | Number of Followed 1 | Stage 3 | ISSN National Journal | - |
| D           | 3.70 | Number of Followed 2 | Stage 2 | 4 | 1 |
| E           | 3.69 | Number of Followed 2 | Stage 2 | 4 | 1 |

a) Build a decision matrix.

Table 8. Assessment based on criteria

| Alternative | C1 | C2 | C3 | C4 | C5 |
|-------------|----|----|----|----|----|
| A           | 5  | 2  | 4  | 1  | 0  |
| B           | 4  | 2  | 3  | 1  | 0  |
| C           | 3  | 1  | 3  | 2  | 0  |
| D           | 3  | 2  | 4  | 4  | 1  |
| E           | 3  | 2  | 4  | 4  | 1  |

b) Build a normalized decision matrix.

Table 9. Normalization Matrix

| r1   | r2   | r3   | r4   | r5   |
|------|------|------|------|------|
| 0.606339 | 0.485071 | 0.492366 | 0.162221 | 0   |
| 0.485071 | 0.485071 | 0.369274 | 0.162221 | 0   |
| 0.363803 | 0.242536 | 0.369274 | 0.324443 | 0   |
| 0.363803 | 0.485071 | 0.492366 | 0.648886 | 0.707107 |
| 0.363803 | 0.485071 | 0.492366 | 0.648886 | 0.707107 |

c) Calculates a weighted normalized matrix (v) whose elements Ri

Table 10. Weighted Normalized Matrix Table

| v1   | v2   | v3   | v4   | v5   |
|------|------|------|------|------|
| 0.18902 | 0.09704 | 0.098473 | 0.024333 | 0   |
| 0.145521 | 0.09704 | 0.073855 | 0.024333 | 0   |
| 0.109141 | 0.048507 | 0.073855 | 0.048666 | 0   |
| 0.109141 | 0.09704 | 0.098473 | 0.097333 | 0.106066 |
| 0.109141 | 0.09704 | 0.098473 | 0.097333 | 0.106066 |

d) Calculating the ideal solution (Si+) and negative ideal solution (Si-)

Table 11. Table of Positive and Negative Ideal Solutions

| Alternative | A+ | A- |
|-------------|----|----|
| A           | 0.18902 | 0.09704 | 0.098473 | 0.097333 | 0.106066 |
| A-          | 0.109141 | 0.048507 | 0.073855 | 0.024333 | 0   |

e) Calculate separation.
Table 12. Table of Separation Values

| Alternative | D+    | D-    |
|-------------|-------|-------|
| A           | 0.128759 | 0.136046 |
| B           | 0.136046 | 0.14789  |
| C           | 0.14789  | 0.072761 |
| D           | 0.072761 | 0.139778 |
| E           | 0.139778 | 0.139778 |

f) Calculating the relative closeness to the ideal solution

Table 13. Table of Preference Values

| Alternative | ci   |
|-------------|------|
| A           | 0.41368 |
| B           | 0.308287 |
| C           | 0.141289 |
| D           | 0.657659 |
| E           | 0.657659 |

g) Then the alternative ranking results obtained

Table 14. Ranking Table

| Alternative | ci   |
|-------------|------|
| E           | 0.657659 |
| D           | 0.657659 |
| A           | 0.41368 |
| B           | 0.308287 |
| C           | 0.141289 |

The following is the interface on the DSS system for the Selection of Undergraduate Scholarship Recipients by applying the Topsis method:

a. Login Form

Login form is the first page that appears when the system starts. To display the login form, you can open it using Google Chrome or the like, type http://localhost/Topsis/ then press enter then enter your username and password.
b. **Main page**
   When successfully logged in, the main page will appear, on this page there are several menus that have been previously designed on the system that was built. Among other things, the home menu, criteria data, student data, topsis results, reports, user data, and logout.

![Figure 2. Main Page](image)

**Figure 2. Main Page**

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c. **Form Criteria Data**
   *FormCriteria Data* is a page that displays the criteria used in this study. On this page there is also a description of the weight of each criterion used. Criteria can be changed or deleted, and criteria can also be added if at any time there is a change in criteria in determining students who receive undergraduate scholarships.

![Figure 3. Criteria Data Form](image)

**Figure 3. Criteria Data Form**

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d. **Form Student Data**
   *FormStudent Data* is a place to accommodate student data belonging to the qualifications of outstanding students. In this form the admin can input student data along with the criteria, this data is then stored for use in the topsis calculation.

![Figure 4. Student Data Form](image)

**Figure 4. Student Data Form**
e. **Form Topsis Results**

*Form* Topsis Results is a page that displays the results of the application of the TOPSIS method on the system being built. The data that has been inputted on the criteria data form is then tested on this form. In this form there are several menus, namely: matrix value, normalized matrix value, normalized weight value (weighted normalized matrix), positive/negative ideal matrix, positive/negative ideal solution distance (separation value), preference value, and menu delete matrix value data.

![Figure 5. Topsis Result Form](image)

f. **Form Report**

*Form* The report is the output of the system that has been built. In this form, the admin can print a report to be used as documentation of the selection of students receiving undergraduate scholarships in the campus environment.

![Figure 6. Report Form](image)

g. **Form User Data**

*Form* User Data is used to display user data on the system.

![Figure 7. User Data Form](image)
3.2. Discussion
As explained in the results section, the highest score as well as the recipient of the Strata-2 scholarship that has been carried out for the data of 5 students at Pelita Nusantara was achieved by alternatives D and E, namely with a value of 0.657659. To be able to access the DSS program for the Selection of Undergraduate Scholarship Recipients, the user must first log in to the system, and data processing can only be done by the admin.

4. CONCLUSION
Based on the research that has been done, the conclusions obtained are; Application of the Topsis Method for the Selection of Undergraduate Scholarship Recipients which was built using 5 criteria, namely: GPA, Career Achievement in Organizations, Discipline, Publication of Scientific Work, and Achievements. Of the 30 students who were nominated, 5 people were used as samples and those who deserved to receive a strata-2 scholarship were alternative initials D and E with the same preference value, namely 0.65765. By applying the Topsis method, it can help the campus in making decisions that are objective on all alternatives that are assessed.

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