Scholarship Decision Support System Using Preference Ranking Organization Method for Enrichment Evaluation

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Abstract—Dompet Dhufa Republika is a nonprofit institute that uplift the dignity of a poor social humanity with ZISWAF funds and other funds lawful and legal, from individuals, groups and companies. The decision making process in the selection of the SMART EI scholarship awardee is still to estimate by Manager and central selection committee based on the poverty of eligible nominee only and must wait for the report from the selection committee in the area for several months. If there is a change in the education system of local education system, it can affect the selection and ranking system. This leads to lack of effective process of determining scholarship awardee. The purpose of this research is in order to design a decision support system that can simplify the process of determining scholarship awardee. To develop Decision Support Systems (DSS) of Scholarship, it apply Rapid Application Development (RAD) using Unified Modeling Language (UML), programming language PHP, XAMPP as a web server and MySQL as database. Refer to interview result with Research Manager, the system is capable of handling and make ease to determine scholarship awardee using PROMETHEE stage II.

Keywords—decision support system; promethee; RAD; scholarship; awardee.

I. INTRODUCTION

Dompet Dhufa Republika is a nonprofit institute that uplifts the dignity of poor social humanity with ZISWAF funds and other funds lawful and legal, from individuals, groups and companies. One of the scholarship programs in Dompet Dhufa Republika is SMART EI. Manager SMART EI and central selection committee have to estimate the scholarship awardee by only poverty of nominees and must wait for the report from local selection committee in few months. Moreover, if there is a change in the local education system, it can affect selection of awardee. In term of the input-process-output logic [1-5], the logic can be used for simplifying the selection process. The objective of this research is simplify the process of determining scholarship awardee with build decision support system.

Some previous research has been done before dealing with Promethee. In addition to its implementation within the organization, DSS is also applied in the fields of education, construction, finance, and company such as employee allocation in accordance with company performance and standards [6]. Refer to [7], they presented DSS to support decision making in portfolio investment with Promethee method. In [8], the process of supporting the manager’s performance in determining employee bonuses with Promethee method was explained in details. Meanwhile, in education field, DSS is also designed to determine the Supereme Scholarship awardee using Promethee [9]. Promethee is used to select suitable machine tool in manufacturing companies [10]. Also, a hybrid between AHP and Promethee can be used to select the equiment [11]. Therefore, authors proposed the DSS of scholarship awardee using Promethee method. The contributions of this research are:

• Specify the criterion to decide scholarship awardee
• Propose the Promethee scholarship awardee model
• Build decision support system for selection of scholarship awardee.

II. LITERATURE REVIEW

A system intended to support managerial decision makers in semi-structured decision situations. Decision support system is a tool for decision makers to expand their capabilities, but not to replace their judgment. DSS is intended for decisions that require judgment or decisions that are not at all supported by algorithm [12].

Multiple Criteria Decision Making (MCDM) is a decision-making method to establish the best alternative of a number of alternatives based on certain criterion. Based on its objectives, MCDM can be divided into two models, Multiple Attribute Decision Making (MADM) and Multi Objective Decision Making (MODM) [13]. Promethee is included in MADM methods. Promethee is a method of determining the order (priority) in a multicriteria analysis. In this method, important information is given from differences by evaluating a criterion and that must be considered in analyzing that is the largest difference, a strong intensity in the choice for a criterion above the other. The alleged predominance of criterion used in Promethee is the use of value in outranking relationships [14].

The aim of Promethee is to be easily for decision maker to solve a problem. In this method, important information is given from differences by evaluating a criterion and must be considered in analyzing that is the largest difference, a strong intensity in the choice for a criterion among the others [15]. Promethee provides user to use data directly in simple multicriteria tables. Promethee has the ability to handle multiple comparisons, the decision maker simply defines its own size scale without constraint, to indicate its
priority and preference for each criterion by focusing on values, without thinking about calculation method.

A. Identify Alternatives and Criterion

The value of f is real value from a criterion: [15]

\[ f : K \rightarrow \mathbb{R} \]

For each alternative \( a \in K \), \( f(a) \) is an evaluation and an alternative to a criterion. An alternative \( a \) is evaluated in some criterion \( k \) which must maximize or minimize it. Intensity delivery \( (P) \) of alternative preferences \( a \) to alternative \( b \):
- \( P(a,b) = 0 \), it means there is no difference between \( a \) and \( b \) or there is no preference from \( a \) better than \( b \).
- \( P(a,b) \sim 0 \), it means weak, preference from \( a \) is better than \( b \).
- \( P(a,b) \sim 1 \), it means strong, preference \( a \) is better than \( b \).
- \( P(a,b) = 1 \), it means absolute, preference \( a \) is better than \( b \).

B. Recommendation Preference Function for Application Purposes

In Promethee, there are six types of criterion functions presented. These are of course not absolute, but its good enough for some cases.

<table>
<thead>
<tr>
<th>CRITERION PREFERENCE</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usual</td>
<td>-</td>
</tr>
<tr>
<td>Quansi</td>
<td>( q )</td>
</tr>
<tr>
<td>Linear</td>
<td>( p )</td>
</tr>
<tr>
<td>Level</td>
<td>( q, p )</td>
</tr>
<tr>
<td>Linear and not different area</td>
<td>( q, p )</td>
</tr>
<tr>
<td>Gaussian</td>
<td>( \sigma )</td>
</tr>
</tbody>
</table>

C. Multicriteria Preference Index

The multicriteria preference index is calculated for each pair of criterion by the following equation.

\[ \sigma(a,b) = \sum_{i=1}^{n} \pi P_i(a,b) \forall a, b \in A \]  

D. Promethee Ranking

The direction of preference is considered based on an index value:
- Leaving flow (LF): \( \Phi_{(a)} = \frac{1}{n-1} \sum_{x \in A} \delta(a,x) \)
- Entering flow (EF): \( \Phi_{(a)} = \frac{1}{n-1} \sum_{x \in A} \delta(a,x) \)
- Net flow (NF): \( \Phi(a) = \Phi_{(a)} - \Phi_{(-a)} \)

III. RESEARCH METHOD

To conduct this research, we apply Rapid Application Development (RAD) approach. There are three steps to develop DSS according to RAD, i.e. Requirements planning, workshop design, and implementation. In Fig. 1, it illustrates DSS development. Each step is include some activities, that must completed before conduct next step. For instance, requirements planning, we must identify the problem in company, gather the information that we need, and solve the problem regarding the previous related work with literature survey and observation. Some tools are required to build DSS, i.e. Unified Modeling Language (UML), programming language PHP, XAMPP as a web server and MySQL as database [16-20].

![Fig. 1. Development of scholarship DSS](image)

IV. MODELING DSS WITH PROMETHEE

Refer to process that described in Fig. 2, scholarship DSS model with Promethee is described as follow:

A. Identify and Determine Criterion

From significant information each nominee, the criterion of scholarship awardee consist of four parameters, i.e. academic report, house index, a number of dependent member’s family, and parent’s salary (Fig. 2). Assessment of these criteria also varies by using a 90-50 scale. For more
details about the description of promethee assessment, it can be seen in Table I.

B. Determine Criterion Dominance, Assessment & Preference

The next step, it illustrates in Table 2, determine the weight of each alternative along with the criterion, the predominance of the criterion, the type of assessment (Max/Min), and the type of preference for each criterion. The following is a process of calculating the weighted criterion applied to an existing alternative:

1) Preference score \( P(a_1, a_2) \) pairs between \( a_1 = \) nominee1 and \( a_2 = \) nominee2, the result as follows:

- For \( f_1 = \) academic report, using Preference I formula: where \( d = \) the difference of criterion score
  \[
  d = f(a_1) - f(a_2)
  \]
  \[
  d = 16.4 - 16.8 = -0.4
  \]
  According to minimize rule, it obtained
  \[
  H(d) = \begin{cases} 
  0, & \text{if } d = 0 \\
  1, & \text{if } d \neq 0
  \end{cases}
  \]
  then \( P(a_1, a_2) = 1 \) and \( P(a_2, a_1) = 1 \)

- For \( f_2 = \) house index, using Preference III formula: where \( d = \) the difference of criterion score, \( p = \) level criterion
  \[
  d = 19.63 - 20 = -0.37; \quad p = 10
  \]
  According to minimize rule, it obtained
  \[
  H(d) = \begin{cases} 
  \frac{d}{p}, & \text{if } -p \leq d \leq p \\
  1, & \text{if } d < -p \text{ or } d > p
  \end{cases}
  \]
  then \( P(a_1, a_2) = -0.037 \) and \( P(a_2, a_1) = 0.037 \)

- For \( f_3 = \) a number dependent member family, using Preference II formula:

\[
\sigma(a,b) = \sum_{i=1}^{n} \pi P_{i}(a,b) \forall a,b \in A
\]
\[
\delta(a_1, a_2) = \frac{1}{4}(1 + (-0.37) + 0 + 0) = 0.24
\]
\[
\delta(a_2, a_1) = \frac{1}{4}(1 + 0.37 + 0 + 0) = 0.26
\]

2) For \( P(a_1, a_3) \), the results become:
\[
\sigma(a,b) = \sum_{i=1}^{n} \pi P_{i}(a,b) \forall a,b \in A
\]
\[
\delta(a_1, a_3) = \frac{1}{4}(1 + 0.8 + 0 + 0) = 0.333
\]
\[
\delta(a_3, a_1) = \frac{1}{4}(1 + (-0.8) + 0 + 0) = 0.17
\]

3) For \( P(a_2, a_3) \), the results become:
\[
\sigma(a,b) = \sum_{i=1}^{n} \pi P_{i}(a,b) \forall a,b \in A
\]
\[
\delta(a_2, a_3) = \frac{1}{4}(1 + 0.375 + 0 + 0) = 0.344
\]
\[
\delta(a_3, a_2) = \frac{1}{4}(1 + (-0.375) + 0 + 0) = 0.156
\]
C. Determine leaving flow, entering flow and net flow score

After it obtained all the preference index score, then with promethee 1 can get leaving flow and entering flow index to determine the relative preference of an alternative to other nominee.

<table>
<thead>
<tr>
<th>Nominee (an)</th>
<th>ai</th>
<th>aj</th>
<th>al</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>-</td>
<td>0.24</td>
<td>0.333</td>
</tr>
<tr>
<td>a2</td>
<td>0.26</td>
<td>-</td>
<td>0.344</td>
</tr>
<tr>
<td>a3</td>
<td>0.17</td>
<td>0.156</td>
<td>-</td>
</tr>
</tbody>
</table>

Table IV shows the leaving flow (LF), entering flow (EF) and net flow (NF) score and ranking level of alternatives.

<table>
<thead>
<tr>
<th>Nominee (an)</th>
<th>LF</th>
<th>EF</th>
<th>NF</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1</td>
<td>0.191</td>
<td>0.143</td>
<td>0.048</td>
<td>1</td>
</tr>
<tr>
<td>a2</td>
<td>0.201</td>
<td>0.132</td>
<td>0.069</td>
<td>2</td>
</tr>
<tr>
<td>a3</td>
<td>0.108</td>
<td>0.226</td>
<td>-0.118</td>
<td>3</td>
</tr>
</tbody>
</table>

V. System Development

To build system design, we use object-oriented model. First, we create use case diagram and its narration. In use case diagram, some activities has been done, for example: identify the system actor and use case. Fig. 3 depicts the use case diagram of scholarship DSS. In this use case, there are two actors, i.e. Administrator and Manager of SMART EI. The manager get the report from PROMETHEE calculation and determine the scholarship awardee. We create the activity, sequence, and class diagram. Finally, we design GUI as interface between system and user (Fig. 4). To complete the system development, it must reach in implementation stage. In this stage, This stage consists of two, i.e. the implementation of a system design into programming language (coding) and system testing by some owners, analyst, and developer with the purpose that a system can run well at the time of operation or there are still errors. At last, the evaluation by manager dealing with this system. Encoding is done by using PHP programming language, and MySQL as its data base as well as web-based and in accordance with it designs.

VI. Conclusion

The criterion for scholarship awardee is determined by scholarship management team (interviews and observations and a regulation of Ministry of National Education. Applying promethee method, the order (priority) of the multicriteria analysis can be determined. Developing decision support system based on web can accelerate the process of determining the scholarship awardee, therefore, it saves time in the selection stage. In the future work, to gain knowledge of approaches and results, it is necessary to determine scholarship awardee using other methods, such as TOPSIS, ELECTRE or metaheuristic approaches. In order to input data into a system, to be more valid and accurate, additional sensitivity test is required.

![Use case diagram of scholarship DSS](image)

![GUI Front end of scholarship DSS](image)

REFERENCES


