Decision making system vocational high school election using promethee method

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Abstract. Vocational High School (SMK) is currently a good choice to continue Reviews their studies, programs offered by vocational schools are one of the factors of student interest, and this makes it difficult, for some parents to determine the right school for Reviews their children. Data and Information as a whole about Vocational Schools can be Obtained through the websites of each Vocational School but it is difficult, to compare them all together, because each has different achievements and advantages. Also, parents still do not know what factors are considered in choosing a vocational school and the tight competition in the world of education to determine the best for Reviews their children in accordance with Reviews their competence and parental conditions. The purpose of this study is to provide information and alternatives in the form of rankings in order to solve problems in the selection of Vocational High School so that it can help parents and the community to choose the right school for Reviews their children. The method used is Promethee as a model for making Recommendations for the selection of Vocational High School education places. The criteria used in the selection of high school vocational education places are location, facilities, number of achievements, school environment, and extracurricular activities. Results the recommendation system for selecting high school vocational education places using the Promethee method can provide information and provide alternatives to solve problems in the selection of secondary vocational schools.

1. Preliminary
At this time the development of computer information technology has been very rapid, ranging from education, medicine, government and all other aspects of life. One of the information is needed by the community is the information of schools in the surrounding area, where this information is necessary for consideration in child choose the right school and as desired.

Based on observations and interviews with parents of students at several middle school First and society in Malang obtained some of the problems currently being faced by the parents and the community that is the difficulty of obtaining data and information that is full of the Vocational High School in the City Poor. Many parents still do not know what factors are taken into consideration in choosing a CMS, the growing number of vocational schools with a variety of skills and achievements that the more intense competition in the world and to show the best education, the more difficult to compare one by one simultaneously. It sometimes makes parents haste in choosing a school for their children without having adapted to his needs and competencies.
Choosing a CMS is not as easy as imagined, much consideration is done by parents before deciding to choose a school. The factors that need to be considered or examined in this study are: location / distance, the facilities, the number of achievements, school environment, and extracurricular activities.

Based on the above, it is necessary to provide the system made the selection recommendation Vocational High School (SMK) that is ideal for older people to be taken into consideration in choosing the right school for their children. The system was developed by using decisions Support System (DSS) / Decision Support System which is an interactive information system that provides information, modeling, and manipulating data. This system is used for decision-making in situations semi structured and unstructured situations, where no one knows for sure how the decision was made. DSS are usually constructed to support a solution to a problem [1].

Turban E, Aronson J E, Peng Liang T states that the decision support system is an intellectual partner of human resources with the computer's ability to improve decisions, namely computer-based decision support system for management decision makers who face semi-structured problems [2]. Several research studies with DSS've done the first by Agus Setiawan that "The Decision Support System Siting Promethee Repair Method" [3]. The system was made to determine the location of the garage belonging AHASS establishment. A second study conducted by N. Arunkumar, S. Godwin Barnabas, N. Dinesh Kumar, T. Kamatchi, Facility Layout Selection for The Blood Inventory Using PROMETHEE II Method [4].

2. Method
The research method used is Promethee (Preference Ranking Organization Method for Enrichment Evaluation), which is one method of determining the order or priority in the MCDM (Multi-Criterion Decision Making).

"Promethee is a method of determining the order (priority) in the analysis of multiple criteria. The central issue is the simplicity, clarity, and stability. The allegations of the dominance of the criteria used in PROMETHEE is the use value of the outranking relationship. All parameters are declared having real influence in the economic outlook" [5].

Step-by-step calculation method Promethee:

2.1. Dominance criteria
F the value of the real value of a criterion:

f: K → R
For each alternative a ∈ K, f (a) an evaluation of the alternatives to a particular criterion. By the time the two alternatives in comparison, a, b ∈ K, must be determined comparison preference. Submission of intensity (P) of the alternative a preference to alternative b such that:

- P (a, b) = 0, meaning no (indifferent) between a and b, or no preference of a better than b.
- P (a, b) ~> 0, means weak preference of a better than b.
- P (a, b) ~> 1 means strong preference of a better than b.
- P (a, b) = 1, meaning the absolute preference of a better than b.

In this method, the function of the preferences often produces a different function values between the two evaluations, thus: P (a, b) = P (f (a) f (b)).

2.2. Determining the type of preference function criteria

- Common Criteria / type I (Usual Criterion)

H(d) = \begin{cases} 
0 & \text{if } d \leq 0 \\
1 & \text{if } d > 0 
\end{cases}
Where :
H (d) = function of the difference between alternative criteria 
d = increment criteria \{d = f (a) f (b)\}
On this criterion is not difference between a and b and only if \( f(a) = f(b) \), if the value of the criteria for each alternative has different values of decision makers has absolute preference for an alternative has a better value.

- **Criteria Quansi / type II (Quansi criteria)**
  \[
  H(d) = \begin{cases} 
  0 & \text{if} \ d \leq q \\
  1 & \text{if} \ d > q 
  \end{cases}
  \]
  Where:
  - \( H(d) \) = function of the difference between alternative criteria
  - \( d = \text{increment criteria} \ \{d = f(a) - f(b)\} \)
  - \( q \) = should be a fixed value

  On this criterion two alternatives have the same preferences is important for the difference or the value of \( H(d) \) of each of the alternatives do not exceed the value of \( q \) and if the difference in the results of the evaluation for each alternative exceeds the value of \( q \) then a form of absolute preference. If the decision makers using quansi criteria, then he must determine the value of \( q \), where this value can explain the significant influence of a particular criterion. Thus \( q \) is an indifference threshold value that is the largest \( d \) value that still allows the indifference between alternatives.

- **Preference Criteria Linear / Type III**
  \[
  H(d) = \begin{cases} 
  0 & \text{if} \ d \leq 0 \\
  \frac{d}{p} & \text{if} \ 0 \leq d \leq p \\
  1 & \text{if} \ d > p 
  \end{cases}
  \]
  Where:
  - \( H(d) \) = function of the difference between alternative criteria
  - \( d = \text{increment criteria} \ \{d = f(a) - f(b)\} \)
  - \( p \) = value of inclination on

  Criteria linear preferences can explain that as long as the differences have a lower value of \( p \), the preferences of decision makers increase linearly with the value \( d \). If the value of \( d \) is greater than the value of \( p \), then there is an absolute preference. At the time identified several criteria for this type should be determined on the value of a tendency (\( p \) value).

- **Criteria Level / Type IV (Level Criterion)**
  \[
  H(d) = \begin{cases} 
  0 & \text{if} \ d \leq q \\
  0.5 & \text{if} \ q < d \leq p \\
  1 & \text{if} \ d > p 
  \end{cases}
  \]
  Where:
  - \( H(d) \) = function of the difference between alternative criteria.
  - \( d = \text{increment criteria} \ \{d = f(a) - f(b)\} \)
  - \( p \) = value of inclination on
  - \( q \) = should be a fixed value

  Here the different tendencies (indifference threshold value) \( q \) and the tendency of preferences (preference threshold) \( p \) are determined simultaneously. If \( d \) is between \( q \) and \( p \) values, this means that the situation of a weak preference (\( H(d) = 0.5 \)).

- **Criteria with linear and area preferences are not / Type V**
  \[
  H(d) = \begin{cases} 
  0 & \text{if} \ d \leq q \\
  \frac{d-q}{p-q} & \text{if} \ q < d \leq p \\
  1 & \text{if} \ d > p 
  \end{cases}
  \]
  Where:
  - \( H(d) \) = function of the difference between alternative criteria.
  - \( d = \text{increment criteria} \ \{d = f(a) - f(b)\} \)
p = value of inclination on 
q = should be a fixed value

In this case the decision makers should consider linearly increased preference of no different
to an absolute preference in the area between the two tendencies q and p, two of these parameters
have been determined.

- Criteria Gaussian (Gausian Criterion)

\[ H(d) = \begin{cases} 
0 & \text{if } d \leq q \\
1 - e^{-\frac{d^2}{2a^2}} & \text{if } d > q 
\end{cases} \]

This function is conditional if the predetermined value of \( \sigma \), which can be made based on the
normal distribution in statistics. Here preference decision makers increased linearly from the
condition of absolute indifference to the preferences in the area between q and p.

2.3. Index multicriteria preference

\[ \varphi(a, b) = \sum_{i=1}^{n} \pi_i P_i(a, b); \forall a, b \in \mathcal{A} \]

Index multi-criteria preference is determined based on the average weight of preference functions \( P_i \).

2.4. Promethee ranking

Calculation directions preferences are considered on flow leaving the index value (), entering flow (),
and the net flow follows the equation:

- Leaving flow

\[ \varphi^+(a) = \frac{1}{n-1} \sum_{x \in \mathcal{A}} \varphi(a, x) \]

- Entering flow

\[ \varphi^-(a) = \frac{1}{n-1} \sum_{x \in \mathcal{A}} \varphi(x, a) \]

- Net flow

\[ \varphi(a) = \varphi^+(a) - \varphi^-(a) \]

Information:

- \( \varphi(a, x) \) = Indicates a preference that the alternative is better than the alternative x.
- \( \varphi(x, a) \) = Indicates a preference that the alternative x is better than the alternative.
- \( \varphi^+(a) \) = Leaving flow, is used to determine the order of priority in the first Promethee process
  that uses a partial sequence.
- \( \varphi^-(a) \) = Entering flow, is used to determine the order of priority in the first Promethee process
  that uses a partial sequence.
- \( \varphi(a) \) = Net flow, used to generate the sequence determination of the final decision in resolving
  the issue so as to produce a complete sequence.
3. Results and discussion

3.1. Data analysis

Analysis of the data needed to design and to build a database system in accordance with the method of assessment is needed. Variable or criteria used are as follows:

- Factors location, location is a considerable factor influencing the vocational school.
- Factors school facilities, Facility is to support the learning process is also important, School Standard must have a class that is comfortable and cool, library, cafeteria, courts for sports, rooms, infirmary, toilets were clean, green parks, and bicycle parking.
- Factors School Achievement, achievement is the result of someone who first achieved in conducting.
- Environmental factors, the school environment is everything that exists around the school that can affect children.
- Extracurricular Factor, should parents choose a school that has extracurricular activities because it helps to develop creativity, talent and interests of children.

It is as expressed by Wiardianti in his study claimed that one of the factors that influence the selection of SMK is the Parent Encouragement and Environment [6]. Research from Santoso also mentions that factors that affect the interests of junior high school students in choosing a vocational school is SMK location, socio-economic background, the closest reference to the student, the student's perception about vocational, student motivation, and vocational courses offered [7].

For each criterion has a weight of each that can be used as a parameter in the selection of primary school education. The following weight rating in the case of the selection of the system on primary education:

- Location (F1)

Table 1. Criteria location.

| Criteria       | Weight |
|----------------|--------|
| one sub-district | 4      |
| What Subdistrict | 3      |
| Far Subdistrict  | 2      |
| Furthest Subdistrict | 1     |

- Facilities (F2)

Table 2. Criteria for facilities.

| Criteria       | Weight |
|----------------|--------|
| Very Good (= 9) | 5      |
| Good (7-9)     | 4      |
| Enough (5-7)   | 3      |
| Less (3-5)     | 2      |
| Very Less (= 3)| 1      |

- Achievement

Table 3. Criteria achievement.

| Criteria       | Weight |
|----------------|--------|
| Very Good (> 5)| 4      |
| Good (3-5)     | 3      |
| Enough (1-3)   | 2      |
| Less than (<1) | 1      |
3.1.1. The dominance criteria. The dominance criteria are some of the criteria used in the design of a recommendation system is taken based on the subjectivity of the decision makers that in this particular case the parents / community. In implementing the PROMETHEE method, the author will use the case as follows:

Pak Azhar living in Klojen, he had children in grades 9 and want to send their children to the CMS. Pak Azhar are confused in choosing the right vocational and ideal for children. Pak Azhar has chosen several elementary schools that have the desired corresponding inter alia:

- SMK STATE 2
- SMK STATE 3
- SMK STATE 5
- SMK STATE 8

In the selection of the system on primary school education, the value received in the form of numbers for each alternative. From the data that have been primary school and obtained the following values:

| No. | Criteria | Value |
|-----|----------|-------|
| 1.  | F1       | 2 3 3 4 |
| 2.  | F2       | 4 4 3 4 |
| 3.  | F3       | 1 3 3 1 |
| 4.  | F4       | 5 4 5 5 |
| 5.  | F5       | 2 2 2 2 |

3.1.2. Determining the type of function preference criteria. At this stage, the comparison between an alternative to other alternatives, by outlining the value of the first alternative with the second alternative, then calculated the value of its preference in accordance with the type of preference is used. Functions used preference is to use common criteria preference function / type I (Usual Criterion).

In this case, there is no difference (equally important) between a and b if and only f (a) = f (b); if the criteria for each alternative has different values, decision makers make an absolute preference for an alternative has a better value.
3.1.3. Preference index multicriteria. Multicriteria preference index is determined based on the average weight of preference functions Pi. Multi-Criteria to obtain the Index preferences as follows:

(A, B) = 1/5 (0 + 0 + 0 + 1 + 0) = 1/5 = 0.2

(AIR CONDITIONING) = 1/5 (0 + 1 + 0 + 0 + 0) = 1/5 = 0.2

(B, A) = 1/5 (1 + 0 + 1 + 0 + 0) = 2/5 = 0.4

(B, C) = 1/5 (0 + 1 + 0 + 0 + 0) = 1/5 = 0.2

(B, D) = 1/5 (0 + 0 + 1 + 0 + 0) = 1/5 = 0.2

(C, A) = 1/5 (1 + 0 + 1 + 0 + 0) = 2/5 = 0.4

(C, B) = 1/5 (0 + 0 + 0 + 1 + 0) = 1/5 = 0.2

(C, D) = 1/5 (0 + 0 + 1 + 0 + 0) = 1/5 = 0.2

(D, A) = 1/5 (1 + 0 + 0 + 0 + 0) = 1/5 = 0.2

(D, B) = 1/5 (1 + 0 + 0 + 1 + 0) = 2/5 = 0.4

(D, C) = 1/5 (1 + 1 + 0 + 0 + 0) = 2/5 = 0.4

Table 7. Index preferences multicriteria.

|    | A   | B   | C   | D   |
|----|-----|-----|-----|-----|
| A  | 0.2 | 0.2 | 0.2 | 0.2 |
| B  | 0.4 | 0.2 | 0.2 | 0.2 |
| C  | 0.4 | 0.2 | 0.2 | 0.2 |
| D  | 0.2 | 0.4 | 0.4 | 0.4 |

3.1.4. Promethee ranking.

- **Leaving Flow**
  
  A = \( \frac{1}{5} \) \((0.2 + 0.2 + 0) = \frac{1}{5} \) \((0.4) = 0.1 \)

  B = \( \frac{1}{5} \) \((0.4 + 0.2 + 0.2) = \frac{1}{5} \) \((0.8) = 0.2 \)

  C = \( \frac{1}{5} \) \((0.4 + 0.2 + 0.2) = \frac{1}{5} \) \((0.8) = 0.2 \)

  D = \( \frac{1}{5} \) \((0.2 + 0.4 + 0.4) = \frac{1}{5} \) \((1) = 0.25 \)

- **Entering flow**
  
  A = \( \frac{1}{5} \) \((0.4 + 0.4 + 0.2) = \frac{1}{5} \) \((1) = 0.25 \)

  B = \( \frac{1}{5} \) \((0.2 + 0.2 + 0.4) = \frac{1}{5} \) \((0.8) = 0.2 \)

  C = \( \frac{1}{5} \) \((0.2 + 0.2 + 0.4) = \frac{1}{5} \) \((0.8) = 0.2 \)

  D = \( \frac{1}{5} \) \((0.2 + 0.2 + 0.2) = \frac{1}{5} \) \((0.4) = 0.1 \)

- **net flow**
  
  A = 0.1 - 0.25 = -0.15

  B = 0.2 - 0.2 = 0

  C = 0.2 - 0.2 = 0

  D = 0.25 - 0.1 = 0.15

Based on the Net flow from the above table it can be obtained rank of each alternative. Alternative D "SMK STATE 8" has the highest net flow and top-ranked, then the alternative D is recommended as a primary school education in accordance with the needs of the elderly, because the alternative D based on the data having the highest value than the alternative C, B and A. If an alternative worth minus means greater value of the flow entering the flow leaving. This means of comparison criteria such alternatives are not better than other alternatives. In alternative A net flown have a negative value which means that the system is not advisable to have a primary school education where appropriate.
Here is a picture context diagram:

Figure 1. Context diagram.

4. Conclusion
Based on the results of the testing system can be concluded that the system is on the selection of secondary school education vocational using methods Promethee been built and can provide information and provides an alternative to solve the problems in the selection of secondary vocational schools so that helps parents and communities in Malang to choose Schools the proper foundation for their children. This is in line with research G. Anand, Rambabu Kodali which states that an extensive analysis of the PROMETHEE models revealed that the LMS method is best for the particular circumstances in the case studies [8]. Another researcher Marko Mladineo.

Based on the results, as for some suggestions related to the research and further development of the system, including the following:

- This system focuses on election recommendation vocational high school in Malang, for the future is expected to be further developed so that the system can cover more broadly.
- Addition of criteria and alternatives such as number of students, number of graduates accepted at State Universities, the average value of a minimum of UAN, and the graduation rate that will add to the accuracy of the system in providing vocational high school selection advice as needed.
- Develop a system by using other methods such as Naive Bayes method, SAW or by any other method so that the system can work perfectly well and as expected.

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