Implementation of Multi-Attribute Utility Theory (MAUT) method for selecting diplomats

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Abstract. Diplomatic relations between countries increasingly show how important the meaning of relations between these countries. Representatives are needed in order to establish cooperative relationships in several fields such as culture, politics, and education. The Ministry of Foreign Affairs is expected to recommend objective representatives to be placed as foreign diplomats. Finding suitable representatives and the number of representatives to be dispatched in accordance with the criteria and rules that apply in the foreign ministry becomes complicated. With this objective and value-weighted recommendation made, it is easier for superiors in the ministry to make representative selection. The method used is the Multi Attribute Utility Method (MAUT) which can make effective and specific selections. Based on the results of testing of 50 sample data to calculate the selection of foreign diplomats using the MAUT method the results were 94%.

1. Introduction

In international relations, cooperation between countries is absolutely necessary. Because there is no country in the world that does not depend on other countries [1]. This is done as an instrument of foreign relations in the implementation of foreign policy, commonly called diplomacy. Diplomacy is conducted to establish, strengthen, and improve relations between one country and another in order to achieve common interests by sending an official representative to the recipient country [2]. The recipient country is the country where the representative is placed. This is closely related to the quality of human resources (labour) that is right for an organization so that management goals are achieved properly and appropriately. So this requires the selection of representatives / diplomats in the foreign ministry. The problem that arises is where the diplomat will fill in the fields / functions needed by the recipient country. In this case representatives are needed to be assigned based on functions required by the recipient country [3]. By using some of the required criteria, the problems faced such as the number of diplomats stationed in several places can be overcome and the process and assessment become objective. If it is not done, this causes prone to manipulation in terms of valuation and error prone. Based on the research conducted, it is required good method to solve this problem such as multi-criteria decision making (MCDM). The paper that we already read for instance multi-attribute utility theory (MAUT). MAUT analysis incorporates consideration of attributes as can be shown by Samstad et al. some decision makers might be reluctant to employ formal methods of decision making [4]. The attitude among some
of the decision makers in their study was that the political decision process could not be subjected to science. It is one of MCDM method used effectively for selecting many criteria. MAUT enables the decision maker to structure a complex problem in the form of a simple hierarchy and to subjectively evaluate a large number of quantitative and qualitative factors in the presence of uncertainty [5]. If in the process of selecting a diplomat assisted by a computerized system, each competency assessment can be done well. Research conducted by Riadhil Jannah using the Multi Attribute Utility Theory (MAUT) method has an accuracy rate of testing of 91.57% [6]. Multi-Attribute Utility Theory (MAUT), proposed by Gunawan and Ramadhan aims to increase accuracy of selection high performing employees [7]. The major advantage of MAUT is that it takes uncertainty into account. It can have a utility assigned to it, which is not a quality that is accounted for in many MCDM methods [8]. Therefore to calculate the assessment in the diplomatic placement process, a method that is suitable with many criteria is needed to find an alternative with the best results. This work proposes a decision support system that can reduce the number of subjectivity problems including the application of the Multi Attribute Utility Theory Method in the experimental phase. Previous methods have been research related to the use of MAUT method in decision making [9-13]. It is important to note that MAUT represents one of many different methodologies to analyse decision-making [14,15]. As used, there are several things that determine the decision making in this selection process as follows the criteria of each alternative and the level of accuracy.

2. Methodology

2.1. Multi-Attribute Utility Theory

According to Schaefer, the Multi Attribute Utility Theory is a final evaluation scheme, \( v(x) \), of an object \( x \) defined as a weight added by a value relevant to its dimension value (utility). MAUT is used to convert several interests into numerical values on a scale from 0-1 with 0 representing the worst choice and 1 being the best. This allows direct comparisons of various sizes [16]. The MAUT is used primarily to solve complex problems that involve the consideration of several criteria in relation to different outcomes. The decision makers assess the values of the possible outcomes based on utility, i.e., the relative desirability of each possible outcome [17]. The end result is a ranking order of alternative evaluations. Evaluation values are entirely defined by the equation:

\[
v(x) = \sum_{i=1}^{n} w_i v_i(x)
\]

(1)

Where \( v_i(x) \) is the evaluation value of an object to \( i \) and \( w_i \) is the weight that determines the value of how important the element \( i \) to other elements. Whereas \( n \) is the number of elements. The total weight is 1.

\[
\sum_{i=1}^{n} w_i = 1
\]

(2)

For each dimension, the evaluation value \( v_i(x) \) is defined as the sum of the relevant attributes. Final equation to produce the best results.

\[
v_i(x) = \sum_{\alpha \in A} w_{\alpha i} v_{\alpha i}(f(\alpha))
\]

(3)

In Figure 1 is the Multi Attribute Utility Theory flowchart procedure. The domain expertise of the decision maker is needed in making decisions when using the MAUT; apart from that she must have a knowledge of the criteria, the value of an alternative available in the data set and the decision maker must understand the concept of MAUT [18]. In another study it was mentioned that there is a multi-attribute concept with a similar concept that is AHP. AHP is generally used for prioritizing the various alternative options available and those options are complex or multi criteria. The basic concept of AHP is essentially the use of pairwise comparison of matrices to generate weights between criteria and between alternatives [19]. Comparing AHP with MAUT, it can be stated that while AHP does not consider uncertainty, MAUT considers uncertainty MAUT is a branch of Multi-Criteria Decision
Analysis (MCDA). MCDA is a structured approach that quantitatively evaluates alternatives in a decision-making process by considering both indicators and their weighting. In MCDA, multiple indicators can be formally incorporated into an evaluation process. The major steps of MCDA analysis are: (1) normalization and evaluation of the performance of each indicator (criterion); (2) determination of the weights representing the priorities for each indicator [20].

![Multi Attribute Utility Theory flowchart procedure.](image)

2.2. Software development method
The prototype model is one method of software development that is widely used by developers because in addition to being simple, this method can also adjust user requirements in detail in making software. This method is able to offer the best approach in terms of certainty about the efficiency of the algorithm, the ability to adjust from an operating site or the forms that must be done by human-machine interaction [21].

3. Results and discussion
This system analysis is a description of a software system and identifies and evaluates the problems of the needs that are expected so that it can be used as well as possible.

3.1. MAUT analysis
Implementation of the system is to do some analysis of the data needs to be used.

- Alternative Data Analysis. Prospective diplomats will be inputted by the admin.
- Value Data Analysis. The value obtained will be entered in accordance with the criteria and weight values that have been determined. To find alternatives approach the user desires then to identifying it as a multiplication predetermined priority scale [22].

The next step is the implementation of the MAUT method in the selection of foreign diplomats:
3.1.1. **Deciding the alternatives.** Prospective diplomats who are registered, have job criteria that are in accordance with their needs and competencies as well as predetermined requirements. This is done because all diplomats will be placed in the destination country on the basis that the diplomatic recommendation is an assignment from the Minister of Foreign Affairs.

3.1.2. **Deciding the weight criteria.** The process of assigning weights to these criteria is very much needed to simplify calculations on the MAUT method. This is done by configuring values. The following is Table 1 Criteria Configuration Value Table. This criteria data is taken from the foreign ministry by entering the criteria parameters into a number of weights that have been determined. Each of these criteria is Position and function, final placement, multiple placements, official education, expertise, language, and performance values. Each has parameters and weighting values are from 1 to 5. This is done to facilitate the assessment process which is then converted into numerical numbers. This numeric number will be processed by entering the weight of each value multiplied by the weight of the preference. Then the next step is normalization. The results of this normalization will be summed and ranked data. So that the best value will be sorted into the first position. The following are data from the Ministry of Foreign Affairs with weight values in Table 1 in the configuration of criterion values. We provide criteria values for all parameters. For quantitative values are given alternatives and change from several interests into numerical values on a scale from 0-1 with 0 being the worst value and 1 the best value can be seen in the Table 1.

| Table 1. Configuring criteria values. |
|---------------------------------------|
| Criteria                | Parameter             | Weight Value |
|-------------------------|-----------------------|--------------|
| Title & Function (C1)   | Not needed            | 1.00         |
|                         | needed                | 2.00         |
|                         | Enough needed         | 3.00         |
|                         | Really needed         | 4.00         |
|                         | Much really needed    | 5.00         |
| Last Placement (C2)     | Been there            | 1.00         |
|                         | Never been there      | 2.00         |
|                         | > 4x                  | 1.00         |
|                         | 3x                    | 2.00         |
|                         | 2x                    | 3.00         |
|                         | 1x                    | 4.00         |
|                         | Never                 | 5.00         |
|                         | Didn’t join           | 1.00         |
| Education (C4)          | Sekdilu               | 2.00         |
|                         | Sesdilu               | 3.00         |
|                         | Sesparlu              | 4.00         |
|                         | Is not needed         | 1.00         |
|                         | needed                | 2.00         |
| Proficiency (C5)        | enough needed         | 3.00         |
|                         | very needed           | 4.00         |
|                         | much really needed    | 5.00         |
| Language (C6)           | Suitable              | 3.00         |
|                         | Not suitable but master English | 2.00 |
|                         | Suitable but not master English | 1.00 |
|                         | 0 – 29                | 1.00         |
|                         | 30 – 49               | 2.00         |
| Performance Rating (C7) | 50 – 69               | 3.00         |
|                         | 70 – 89               | 4.00         |
|                         | 90 – 100              | 5.00         |
### Table 2. Preference weight.

| No. | Criteria | Percentage | Preference Weight |
|-----|----------|------------|-------------------|
| 1   | C1       | 25 %       | 5.00              |
| 2   | C2       | 15 %       | 3.00              |
| 3   | C3       | 18%        | 3.00              |
| 4   | C4       | 20 %       | 4.00              |
| 5   | C5       | 5 %        | 2.00              |
| 6   | C6       | 7 %        | 2.00              |
| 7   | C7       | 10 %       | 3.00              |

### Table 3. Example calculations.

| No. | X   | C1  | C2  | C3  | C4  | C5  | C6  | C7  |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1   | A1  | 5.00| 2.00| 1.00| 4.00| 2.00| 4.00| 3.00|
| 2   | A2  | 3.00| 2.00| 1.00| 3.00| 2.00| 3.00| 3.00|
| 3   | A3  | 3.00| 1.00| 2.00| 3.00| 2.00| 3.00| 3.00|
| 4   | A4  | 5.00| 1.00| 4.00| 4.00| 3.00| 4.00| 4.00|
| 5   | A5  | 3.00| 2.00| 5.00| 2.00| 2.00| 3.00| 4.00|
|     | W   | 5.00| 3.00| 4.00| 2.00| 2.00| 3.00| 4.00|

Giving weights based on the interests of each existing criteria, with the largest weight to the smallest at intervals of 0-100 like the table above Table 2 Preference Weight. Table 3 is a manual calculation from the sample data.

### Table 4. Example of normalization results.

| X   | C1  | C2  | C3  | C4  | C5  | C6  | C7  |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 1   | A1  | 1   | 1   | 0   | 1   | 0   | 0   |
| 2   | A2  | 0   | 1   | 0   | 1   | 0   | 0   |
| 3   | A3  | 0   | 0   | 0   | 1   | 0   | 0   |
| 4   | A4  | 1   | 0   | 1   | 1   | 1   | 1   |
| 5   | A5  | 0   | 1   | 1   | 0   | 0   | 0   |

**Weight**

5.00  3.00  3.00  4.00  2.00  2.00  3.00

The next step is to count the matrix normalization:

$$U_\omega = \frac{x_i - x^{-}_i}{x^+_i - x^{-}_i}$$  \hspace{1cm} (4)

\(x_i\) \~ Worst value of \(x\) and \(x_i\) the best value of \(x\). The normalization results are in table 4.

$$V(x) = \sum_{i=1}^{n} w_i x_{ij}$$  \hspace{1cm} (5)

Where \(V(X)\) is the evaluation value of an object from \(i\) and \(W_i\) is the weight that determines the value of how important \(i\) to the other elements. Whereas \(n\) is the number of elements. The total weight is 1.

The following Table 5 results of the matrix normalization matrix multiplication from Multy Attribute Utility Theory. Here is table 5 multiplied matrix & value weights. From Table 5, it will get the ranking as can be seen in Table 6.

### Table 5. Example of the results of the normalization matrix multiplication.

| No. | X   | C1  | C2  | C3  | C4  | C5  | C6  | C7  | Z   |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1   | A1  | 1   | 5   | 1   | 3   | 0   | 2   | 1   | 4   | 14  |
| 2   | A2  | 0   | 5   | 1   | 3   | 0   | 3   | 1   | 4   | 7   |
| 3   | A3  | 0   | 5   | 0   | 3   | 0   | 3   | 1   | 4   | 4   |
| 4   | A4  | 1   | 5   | 0   | 3   | 1   | 3   | 1   | 1   | 4   |
| 5   | A5  | 0   | 5   | 1   | 3   | 1   | 3   | 0   | 4   | 9   |

### Table 6. Ranking results.

| No. | Alternative | Total Score |
|-----|-------------|-------------|
| 1   | A4          | 19          |
| 2   | A1          | 14          |
| 3   | A5          | 9           |
| 4   | A2          | 7           |
| 5   | A3          | 4           |
3.2. Testing
Calculation of system accuracy is needed to find out the results of the diplomatic election system. The accuracy of the diplomatic election system = \frac{47}{50} \times 100\% = 94\%. These results are based on testing of 50 test data samples obtained 47 appropriate data, then the diplomatic selection system is valid with an accuracy rate of 94%. In the test results there are some data that have a difference value that makes the test different. This is due to the rounding that occurs in the normalization process. This data mismatch occurs in the final ranking results. This happens between the differences in the calculation of the system weights with the calculation of manual weights or real data. There are 3 numbers of samples that have a difference in this test. So that the results of this test are very accurate with an accuracy value of 94%. Samples taken in this study were taken directly from random foreign ministry data. Of the 50 real data all of them are in accordance so that the data can be entered into the system to be made. The next step is to prove the comparison of the accuracy of the system with the manual.

4. Conclusion
There are some conclusions from this study are:

- The implementation of the MAUT method in the system built is able to produce a ranking of diplomat candidates with a value that can be sorted.
- The level of accuracy of MAUT in the selection process of diplomats can run well and accurately, so this method is suitable for use in assessments involving many alternatives and criteria with testing that has been done on system accuracy where manual calculations are compared with system calculations. The results of testing the accuracy of the system that has been carried out, namely from 50 test data obtained 47 data that is appropriate so that the accuracy rate reaches 94%.

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