Decision Support Systems for Performance and Evaluation of Teachers in General-English Course by Using the SMARTER and TOPSIS Methods

Rasim*, E F Rahman, N F Dewi, and L S Riza
Department of Computer Science Education, Universitas Pendidikan Indonesia, Indonesia
*Rasim@upi.edu

Abstract. This research aims to implement Decision Support System (DSS) for choosing General English program teacher using Smarter and Topsis methods. The SMARTER method is used for determining weight of each criterion, where the TOPSIS method is used for calculate teacher ranks. The data used consist of some criteria and lecturer scores for each parameter. Both data are obtained from UPI Language Center Customer Satisfaction Report. Priority of criteria was decided based on questionnaire response from General English Program students. On accuracy aspect, the research shows that the combination of SMARTER and TOPSIS methods has 76% error rate. This research also shows that SMARTER and TOPSIS method has 90% stability. Based on questionnaire, 4 from 5 Balai Bahasa UPI’s management choose teacher’s rank from SMARTER and TOPSIS methods rather than manual.

1. Introduction
One of the most favorite training programs in UPI Language Center is General English. It can be seen from the number of the classes opened for training. Classes opened for General English training are always more than other programs in UPI Language Center.

At this time, UPI Language Center have 21 instructors who teach on General English Training Program by dividing to different classes. Because it has a considerable interest, then it is very important for the Language Center to evaluate the performance of General English Program teachers. In order to determine the performance of teachers and see ratings of teachers, the Language Center managerial assessment, called a Customer Satisfaction Report, should be done. The report was obtained from questionnaires filled by General English trainees at the end of the learning period. But until now the reports were processed in manual ways and by using same weights criteria between one criterion to the other criteria. Based on the results of the questionnaire that were distributed to the General English trainees to determine which criteria become a priority. The result shows the percentage of interest to the criteria of the Learning Atmosphere 96.29%, 94.82% Submission Material, Hospitality Educator 94.44%, accuracy of time Lecturer 92.59%, 91.85% chance inquiry, and Conformance Test Materials with 89.63%. It shows the different priorities for each criterion. Where it has not been applied to the assessment report already existing Customer Satisfaction. So, it seems that there is a discrepancy results in the process of teachers’ ranking manually. It makes confusion in the division of classes and teaching hours of these teachers.

To get the ranking is more accurate and in accordance with criteria that are prioritized by the General English trainees, then made a decision support system for evaluating performances of teachers in
training General English programs that are capable of performing calculations weighting of criteria based on the priorities of these criteria and ranking in accordance with the priority criteria. It can be determined an atmosphere of learning, speech delivery, hospitality teacher, timeliness of teachers, the opportunity to ask, and compliance with the test material.

An evaluation of teacher performances is a process involving a lot of criteria (multi-criteria), so that completing the process takes a decision support system with Multi-Attribute Decision Making (MADM). Some methods used for solving the problems included in MADM are as follows: Promethee, Simple Multi-Attribute Rating Technique Exploiting Rank (SMARTER), ELECTRE, Weighted Product, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Simple Additive weighting (SAW), etc. In this research, we focus on two of them, that are SMARTER and TOPSIS.

The SMARTER method is chosen because it can be used to identify key criteria that should be considered [1]. In addition, SMARTER method is simple to use and used linear approximation to single-dimension, and swing weights. The SMARTER method used to determine the weight of each criterion in a decision [2]. The SMARTER has been decided as one of the most suitable for the exploitation of the results achieved by the factor analysis [3].

While the TOPSIS method is selected because it can provide an effective solution to certain problems containing multi-criteria that chosen alternative should have the shortest distance from the Positive Ideal Solution (PIS) and the farthest from the Negative Ideal Solution (NIS) [4]. It combines quantitative attributions (such as price, time, distance, etc.) and qualitative attributions (such as quality of relationship, quality assurance, reliability) and compares all alternatives together based on these attributions [5].

Therefore, we intend to build a decision support system to evaluate the performance of General English teaching program using the SMARTER and TOPSIS. SMARTER will be used to determine the weight of each criterion where TOPSIS is used for the process of ranking the alternatives.

2. Decision Support Systems and Its Related Work
DSS is a system intended to support decision-making managerial decisions in situations semi structured. DSS is meant to be a tool for decision makers to expand their capabilities, but not to substitute their judgment [6]. There are many methods that can be used for DSS, but in this paper, we focus on two following methods: SMARTER and TOPSIS.

2.1. Simple Multi-Attribute Rating Technique Exploiting Rank Method (SMARTER)
It is an extension of the following method: Simple Multi-Attribute Rating Technique (SMART), which provides a mechanism for implementing the principles of Multi-Attribute Utility Theory (MAUT). The difference between them is the way of the weighting. In these methods, weighting criteria depends on the priority order starting attributes of attributes that are considered most important in order of priority first. The SMARTER method employs a systematic procedure in evaluating the attributes from a number of dimensions in a full range. The framework adopted in the developed models is of generic nature, and additional criteria (apart from the demonstrated attributes in this paper) could easily be appended [7]. To overcome these problems, SMARTER uses the weighting formula ROC (Rank Order Centroid).

According to Jeffreys, ROC technique gives weight to each criterion according to the ranking based on the level of priority [8]. Usually it is formed with the following statement “one more important criteria than the criteria, the more important of the criteria 3” and so on until all n criteria, written $CR_1, CR_2, \ldots, CR_n$. To determine its weight, given that the same rules $W_1 \geq W_2 \geq \ldots \geq W_n$ where $W_i$ is the weight for criterion $C_i$.

Furthermore, if $x$ is a number of criteria, then
In general weighting ROC, can be formulated as follows:

\[ W_k = \frac{1}{k} \sum_{i=1}^{k} \left( \frac{1}{n} \right) \]

If two or more of the criteria are considered equally important, the weight given to each criterion is the average of the combined ranking. For example, if \( CR_1 \geq CR_2 = CR_3 \), means criterion 1 is more important than 2 criteria are equally important criteria 3. Then the weight given are as follows:

\[ CR_1 = W_1 = 0 \]
\[ CR_2 = \frac{W_2 + W_3}{2} = \frac{0.278 + 0.111}{2} = 0.1945 \]
\[ CR_3 = \frac{W_3 + W_3}{2} = \frac{0.111 + 0.278}{2} = 0.1945 \]

According to Edwards and Baron there are two things that underlie the SMARTER method [2], namely:
- The technique is simple, so it can be used by decision makers.
- The technique is easy to obtain a reliable decision.

Here are the steps of the method SMARTER:
- Identify the problem, so as to formulate a decision to be taken.
- Specify the alternative, criteria and sub criteria used in making decisions.
- Provide the ranking for each criteria and sub-criteria.
- Calculated using weighted ROC weights to each criterion, it relies on the ratings given in step iii.
- Calculate the final weight of each criterion.
- Provide an assessment on all criteria for each alternative. (vii) Calculate the utility to each alternative using the equation,

\[ W_j U_{ij}, \forall 1 \text{ to } n \]

- Decides, if only one alternative will be selected, it will have an alternative with the greatest utility value.

2.2. Technique for Others Reference by Similarity to Ideal Solution Method (TOPSIS)

It was proposed by Hwang and Yoon in 1981 for obtaining performance data for \( n \) alternatives over \( k \) criteria. Raw measurements are usually standardized, converting raw measures \( x_{ij} \) into standardized measures \( s_j \) [9]. In this method, the main concept is that the most preferred alternative should have the shortest distance from PIS and the longest distance from NIS. PIS is the one that maximizes the benefit
criteria and minimizes the cost criteria, while the NIS functions in the opposite way [10]. There are many advantage of using the TOPSIS method, as follows [11]:

- It is simple to use.
- It takes into account all types of criteria (subjective and objective).
- It is rational and understandable.
- The computation processes are straight forward.
- The concept permits the pursuit of best alternatives criterion depicted in a simple mathematical calculation

Positive ideal solution is defined as the sum of all the best value that can be achieved for each attribute, while the negative ideal solution consists of all the worst value achieved for each attribute. TOPSIS into account both the distance of the negative ideal solution by taking the relative proximity to the positive ideal solution. Based on the comparison of the relative distance, alternative priority order can be achieved. Here are the steps of TOPSIS:

- Ranking of each alternative: TOPSIS requires ranking the performance of each alternative $A_i$ on each criterion $C_j$ normalized

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

where $i = 1, 2, ..., m$ and $j = 1, 2, ..., n$.
- The weighted normalized decision matrix:

$$y_{ij} = r_{ij}w_i$$

- The ideal solution both positive and negative ideal solution: Positive ideal solution $A^+$ and $A^-$ negative ideal solution can be determined based on ranking weight normalized ($y_{ij}$) as follows:

$$A^+ = (y_{11}^+, y_{21}^+, \ldots, y_{n1}^+)$$

Where $y_{ij}$ is the max of $y_{ij}$, if $k$ is an attribute gain and min of $y_{ij}$, if $j$ is an attribute cost,

$$A^- = (y_{11}^-, y_{21}^-, \ldots, y_{n1}^-)$$

Where $y_{ij}^-$ is min of $y_{ij}$, if $k$ is an attribute profit and max of $y_{ij}$, if $j$ is an attribute cost.

- The distance to the ideal solution: The distance of the alternative $A_i$ with a positive ideal solution formulated as: while the

$$D_i^+ = \sqrt{\sum_{j=1}^{m} (y_{ij} - y_{ij}^+)^2}$$

$$D_i^- = \sqrt{\sum_{j=1}^{m} (y_{ij} - y_{ij}^-)^2}$$

Table 1. Brief survey on DSS

| No | Refs | Methods         | Applied Fields                      |
|----|------|-----------------|-------------------------------------|
| 1  | [12] | TOPSIS          | Industry                            |
| 2  | [9]  | TOPSIS and SMART| Comparison method                   |
| 3  | [1]  | SMARTER         | Industry                            |
| 4  | [3]  | SMARTER         | Complexity Measurement in Engineering Project |
| 5  | [4]  | TOPSIS          | Industry                            |
| 6  | [5]  | TOPSIS          | Supply chain                        |
| 7  | [13] | TOPSIS          | Warehouse location                  |

- Preference value for each alternative: Preference value for each alternative ($V_i$) is given as:

$$V_i = \frac{D_i^+}{D_i^- + D_i^+}$$
2.3. Related Work
In this study, we describe some earlier researches that can support for solving the issues. The review can be seen in Table 1.

3. Research Methodology

3.1. Research Design
In this study, the research methods used can be seen in Figure 1. It can be seen that there are four processes in this research: formulate the issue, interview and study literature, software development, and software testing. Moreover, we need to supply data containing criteria and alternatives.

3.2. Data Gathering
The following are processes in order to obtain the data:
- The primary data collection, namely by distributing a questionnaire on criteria that most affect the success of the process of teaching English to the trainee program at the Center for General English UPI Language Center.
- Secondary data collection, namely by collecting data on its assessment of General English teacher training programs of trainees (Customer Satisfaction Report) in recent periods.

| No | Criteria                      | Values   |
|----|-------------------------------|----------|
| 1  | Atmosphere of learning       | 96.296%  |
| 2  | Submission of materials      | 94.815%  |
| 3  | Teacher’s hospitality        | 94.444%  |
| 4  | Teaching timeliness          | 92.592%  |
| 5  | Inquiry opportunity          | 91.852%  |
| 6  | Compliance with the test material | 89.63% |
| 7  | Openness to complaints       | 87.407%  |
| 8  | Teachers neatness            | 75.185%  |

- The study of literature, which is studying the theory and methods used to study the literature, lecture notes, theses, journals and other materials obtained from various sources such as articles and internet-related research.

Figure 1. Research methodology for implementation of SMARTER and TOPSIS.
4. Results and Discussion

4.1. System Analysis
Firstly, we build a system providing ranking of teachers in the General-English program, with the aim to help the managerial UPI Language Center. Until now, this process is done in a manual way by using questionnaires filled out by teachers at the end of each period, called Statement Customer Satisfaction. Therefore, the results are not necessarily accurate and in accordance with the criteria required by the program. It also means that the process allows for subjective assessment. In the other hand, this study will produce a system that can facilitate the managers in making ranking of performance and evaluation the program.

4.2. Results of Field Studies and Interviews
From interviews with the head of the Division of UPI Language Center, teacher ratings for General English courses is a routine activity performed when each training period has been completed. It is done by distributing questionnaires to trainees at the end of the training period to assess the performance of teachers. So, the assessment is based on criteria predetermined by the institution.

4.3. Dissemination Questionnaire Results
A result of questionnaire showing the priority criteria is illustrated in Table 2. From these results, we take 6 top priority criteria, namely an atmosphere of learning, speech delivery, hospitality teacher, timeliness of teachers, the opportunity to ask, and suitability of materials with tests.

4.4. Case Analysis
In the analysis of this case, it will be discussed on how the calculation of SMARTER-TOPSIS. We consider 5 teachers General English courses, namely Nida Fauzia, Budi Hermawan, Rifni Nurrahmi, Vidi Sukmayadi, and Indiana Ayu. Here is an alternative that is initialized in the analysis:

- \( A_1 = \) Alternative 1 (Nida Fauzia)
- \( A_2 = \) Alternative 2 (Budi Hermawan)
- \( A_3 = \) Alternative 3 (Rifni Nurrahmi)
- \( A_4 = \) Alternative 4 (Vidi Sukmayadi)

\[ \text{Table 3. Comparison: manual and SMARTER-TOPSIS} \]

| No | Name     | Manual | SMARTER-TOPSIS | No | Name     | Manual | SMARTER-TOPSIS |
|----|----------|--------|----------------|----|----------|--------|----------------|
| 1  | Tubagus  | 16     | 14             | 12 | Nur K.   | 18     | 19             |
| 2  | Rika N.  | 5      | 5              | 13 | Budi H.  | 21     | 20             |
| 3  | Lukman   | 7      | 7              | 14 | Ari A.   | 9      | 8              |
| 4  | Evi K.   | 6      | 4              | 15 | Rustian  | 12     | 11             |
| 5  | Eka R.   | 10     | 12             | 16 | Diana    | 20     | 21             |
| 6  | Fauzi Y. | 8      | 10             | 17 | Vidi S.  | 1      | 1              |
| 7  | Nida F.  | 13     | 13             | 18 | Tri R.   | 2      | 2              |
| 8  | Andrian  | 14     | 15             | 19 | Raden    | 11     | 9              |
| 9  | Jeani S. | 15     | 17             | 20 | Rifni N. | 19     | 16             |
| 10 | Indiana  | 3      | 6              | 21 | Sri N.   | 4      | 3              |
| 11 | Ihsan    | 17     | 18             |

- \( A_5 = \) Alternative 5 (Indiana Ayu)

For the criteria, will be initialized as follows:

- \( C_1 = \) Criteria 1 (The atmosphere of learning)


- $C_2 =$ Criteria 2 (Submission of materials)
- $C_3 =$ Criteria 3 (Teacher’s hospitality)
- $C_4 =$ Criteria 4 (Teaching timeliness)
- $C_5 =$ Criteria 5 (Inquiry opportunity)
- $C_6 =$ Criteria 6 (Compliance with the test material)

After the data are inserted into the system, we obtain the ranking as the SMARTER-TOPSIS Result: Vidi Sukmayadi (0.968), Indiana Ayu (0.814), Nida Fauziah (0.648), Rifni Nurrahmi (0.607), and Budi Hermawan (0.112).

4.5. Measurement of Testing

4.5.1. Accuracy. Comparison of the results by hand using a formula that already exists with the result generated by the methods is shown in Table 3. It can be seen that the number of match is 5 whereas 16 names are mismatch.

4.5.2. Stability. The stability test of three methods: SMARTER, TOPSIS, and combined method (i.e., SMARTER-TOPSIS) has been done by the elimination of the alternative with the lowest ratings. It should be noted that a stable method is the best alternative where the sequence does not change when the alternative is chosen. So, in general speaking, we obtain results showing stability of 10 times of experiments using a variety of data and selected at random as illustrated in Figure 2. We can state that the stability of method SMARTER-TOPSIS is 90%. It means that SMARTER-TOPSIS is the most stable when compared with the others.

5. Conclusions and Future Work

The usage of the combined method (i.e., SMARTER and TOPSIS) can be an alternative to assist in measuring the performance and evaluation program of General English courses’ teachers in UPI Language Center. It provides 76% for the error rate or difference with the results produced by ranking manually. Moreover, based on a questionnaire, 4 out of 5 people would prefer the managerial rank results by the combined method than the manual way. The percentage of stability measurement of system is 90%.

Figure 2. Results: stability of SMARTER, TOPSIS, and combined method (i.e., SMARTER-TOPSIS) in 10 times of experiments.

As future work, we plan to extend the diagnosis of sleep order by using Fuzzy Rule-based Systems [14, 15] and Rough Set Theory [16].

References
[1] Schramm F and Morais D C 2012 Pesquisa Operacional 32 643–662
[2] Edwards W and Barron F H 1994 Organizational behavior and human decision processes 60
306–325
[3] Manoliadis O and Vasilakis E 2016 *American Journal of Management Science and Engineering* **1** 48–55
[4] Jadidi O, Firouzi F and Bagliery E 2010 *World Academy of Science, Engineering and Technology* **47** 956–958
[5] Shahroudi K and Tonekaboni S M S 2012 *Journal of Global Strategic Management* **12** 123–131
[6] Aronson J, Liang T and Turban E 2005 *Yoyakarta: Andi* 24
[7] Reddy K, Xie N and Subramaniam V 2004
[8] Jeffreys I 2004 Small-scale Forest Economics, Management and Policy **3** 99–117
[9] Olson D 2004 *Pergamon* **1** 1–7
[10] Madi E N, Tap M and Osman A 2011
[11] Bhutia P W and Phipon R 2012 *IOSR Journal of Engineering* **2** 43–50
Bezhadian M, Otaghsara S K, Yazdani M and Ignatius J 2012 *Expert Systems with Applications* **39** 13051–13069
[12] Ashrafzadeh M, Rafiei F M, Isfahani N M and Zare Z 2012 *Interdisciplinary Journal of Contemporary Research in Business* **3** 655–671
[13] Riza L S, Bergmeir C, Herrera F and Ben’itez J M 2014 Learning from data using the R package frbs 2014 *IEEE International Conference on Fuzzy Systems (FUZZ-IEEE)* pp 2149–2155
[14] Riza L, Bergmeir C, Herrera F and Ben’itez J 2015 *Journal of Statistical Software* **65** 1–30
[15] Riza L S, Janusz A, Bergmeir C, Cornelis C, Herrera F, Slezak D and Ben’itez J M 2014’ *Information Sciences* **287** 68–89