

An Analytical Approach of Topsis in Data Analysis

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ABSTRACT

TOPSIS method is used to solve Multiple Criteria Decision-Making problems. It is applied in various fields including engineering, human resources, finance and construction industry. There are two main objectives in this paper. First, an analytical approach of applying TOPSIS in analysing data collected using questionnaire is developed in this paper. Second, the data collected in this study aim at investigating the perception of online assessment among the lecturers in the university. Online assessment is an adoption of technology in the process of teaching and learning. Using online facility to conduct assessment provides many advantages to the lecturers and students especially the flexibility in teaching and learning. With the advancement of technology in this era, online assessment is highly encouraged and endorsed by the university. The analysis using TOPSIS method in this paper successfully produced the ranking of the lecturers based on their acceptance level of using online assessment. This finding can help administration in the university to understand the acceptance level of using online assessment among the lecturers. The ranking of the lecturers may also help the administration to identify who need to attend professional development program in order to increase their usage of online assessment in their courses. The method of applying TOPSIS in analysing data collected using questionnaire is not common in the application of TOPSIS. The approaches and findings presented in this paper can be served as a reference for other researchers who involve in similar data collection method in future.

Keywords: TOPSIS; data analysis; optimal ranking; multiple criteria; acceptance level.

1. INTRODUCTION

TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method could be used to assist decision makers in choosing the best alternative when multiple criteria are to be evaluated on a number of alternatives. TOPSIS was initially presented by Hwang and Yoon [1]. The decision maker in an organization can be a manager who wants to select a best location to set up a new factory by considering many criteria such as cost and location. A recruitment manager oftentimes needs to make decision in selecting the best candidate to be hired based on different skills, knowledge and attributes that the candidates possess. The earlier mentioned examples show that multiple criteria need to be considered at all the time by the decision makers.

When multiple criteria exist in a real life problem, a number of alternatives that might meet the criteria usually are available to be evaluated. To select the best alternative that meets the optimal requirement of the multiple criteria, TOPSIS method is used. TOPSIS is a method to

solve Multiple Criteria Decision-Making problems. TOPSIS method is applied in many different fields such as finance, engineering, human resources and management. Tabriz and Aliakbarzadeh [2] applied TOPSIS method in measuring performance for 13 branches of financial institutes. TOPSIS method is also used in solving problem in the engineering application [3]. The study in [3] shows that TOPSIS is applied in material selection for the automotive parking brake lever component. Abdullah and Zamri [4] applied TOPSIS in ranking factors associated with road accidents. TOPSIS method can also be used in selecting the best location for a factory [5]. To help human resources department in selecting potential candidates for the position of managers, TOPSIS is applied in the process of decision making [6]. In construction industry, Ng and Chew [7] applied TOPSIS in selecting capable bidders to whom to award a contract.

In this paper, TOPSIS method is applied in analysing data collected from questionnaire with Likert scale of items. There are two main objectives in this paper. First, an analytical approach of applying TOPSIS in analysing data collected using questionnaire is developed in this paper. The TOPSIS analysis method presented in this paper can be served as a reference for other researchers who involve in similar data collection method in future. Second, the data collected in this study aim at investigating the perception of using online assessment among the lecturers in the university. The analysis using TOPSIS method enables the ranking of the lecturers based on their acceptance level of using online assessment is produced. This finding can help administration in the university to understand the acceptance level of using online assessment among the lecturers.

2. BACKGROUND OF THE STUDY

The advancement of technology in this era has provided the opportunity for the educators as well as students who wish to try out new experience in teaching and learning process. E-learning refers to the use of Internet technologies in the process of teaching and learning [8]. There are many tertiary education institutions in Malaysia that provide online system for the purpose of teaching and learning. The online teaching and learning system is generally known as Learning Management System. Since late 2004, 88% of tertiary education institutions in Malaysia are equipped with online teaching and learning system [9]. With the support of online teaching and learning system, the use of technology in teaching and learning in higher education is getting popular.

There are several factors contribute to the successfulness of the implementation of e-learning program in tertiary education institutions. Goi and Ng [10] summarized the success factors in implementing e-learning program as program content, web page accessibility, learner's participation and involvement, web site security and support, and institution commitment. With the emergence of e-learning in this new era, the traditional face-to-face teaching still has its advantages and uniqueness. Therefore, a combination of e-learning and face-to-face teaching has formed a new way of teaching. This type of teaching and learning method is called Blended learning [11].

When a teaching and learning process is carried out, assessment plays an important role in evaluating the effectiveness of the process of teaching and learning. The assessment is conducted after the learning process has begun. The results of the assessment are a form of feedback to the educator as well as the students as an indicator of how effectively the teaching

and learning activity has been carried out. The assessment is usually a quiz or a test that is conducted during the period of learning. In tertiary education, quizzes and tests are given during the semester. The students can oftentimes obtain the feedback from the quizzes or tests and may further improve on the areas that they are weak in based on the result of the quizzes or tests. The quizzes and tests that are conducted during the semester are a form of formative assessment. At the end of the semester, final examination is conducted as an assessment to evaluate the overall performance of the students on the course. The final examination is a form of summative assessment. Assessment is a process that has been long existed in the formal education history. Before the introduction of technology in education, the assessment is usually carried out in the form of paper-based. The paper-based type of assessment is commonly seen in the classroom where all the students are only provided with papers and pen to answer the questions.

With the advancement in technology, the form of assessment is no longer limited to the paper-based type of assessment. A new type of assessment that involves the use of online facility has started attracting the interest of educators and students. To conduct the online assessment, the questions of the assessment are first uploaded to an online system or a web-based application by the educators. Then, online assessment can be carried out at any place where the online facility is accessible by the students. Thamadharan and Maarop [12] stated that online assessment provides many advantages to the users especially the flexibility in teaching and learning. The online assessment can be utilised in the courses supported by e-learning as well as the courses that adopt Blended learning. For e-learning, online assessment can be conducted in online teaching and learning system provided by the education institutions. In general, a study shows that the main reasons of online teaching and learning system usage among students are to obtain lecture notes, submit assignment and undertake online quizzes [13].

For Blended learning, the online assessment can be conducted after a face-to-face teaching is carried out. Nowadays, the Internet access is not only limited with the use of computer and laptop, many electronic gadgets such as smartphone, tablet and phablet also have the Internet access. With the popularity of owning computer, laptop as well as smartphone among the students, the implementation of online assessment in tertiary education institutions has become more practical. Since the concern and attitude towards the use of online assessment among the lecturers could contribute to the successfulness of the implementation of online assessment in their courses, the acceptance level of using the online assessment among the lecturers in tertiary education institutions should be investigated.

3. METHODOLOGY

3.1 Identification of Criteria for TOPSIS Analysis

In TOPSIS, multiple criteria that are considered in the decision making are divided into two categories. The first category consists of the criteria that possess positive impact. The second category consists of the criteria that possess negative impact. TOPSIS method has the advantage of selecting the best alternative that meets the criteria with the most positive impact in the first category and has the least negative impact on those criteria in the second category.

In this study, TOPSIS method is applied in analysing data collected from questionnaire using Likert scale of items. Questionnaire was distributed to evaluate the perception of using online

assessment among lecturers. There are a total of 31 lecturers in Universiti Teknologi MARA (UiTM) Penang branch voluntary involved in this survey. Among the 31 lecturers, 6 of them are in the field of Computer Science, 19 in Mathematics and 6 in Statistics. The participants are required to complete a self-administered questionnaire. The items in the questionnaire were rated on a 1-7 Likert scale (from strongly disagree to strongly agree). The scales allow the participants to express how much they agree or disagree with a particular statement. In this paper, analysis is done on 9 selected items taken from the self-administered questionnaire. The items can be divided into two categories as shown in Figure 1. The first category consists of 6 items representing high acceptance level of using online assessment if the participants choose a higher Likert scale. The 6 items evaluate the following aspects:

- The appropriateness of online assessment for the courses in the field of the lecturers.
- Students' grades for online assessments are secured.
- Prefer answering online assessment than paper-based assessment because students nowadays are Internet-savvy.
- Intend to use more often online assessment for the courses in the field of the lecturers.
- The functionality of the online assessment is better than paper-based assessment.
- Score for the online test or quiz can be obtained immediately.

The second category consists of 3 items representing high acceptance level of using online assessment if the participants choose a lower Likert scale. The 3 items evaluate the following aspects:

- Students having stress when answering online test or quiz.
- Online assessment is impractical due to technical problem.
- The i-Learn system (online teaching and learning system) used in online assessments is unreliable.

These two categories match the criteria in TOPSIS. Thus, 6 questions in the first category are representing the criteria that possess positive impact while 3 questions in second category are representing the criteria that possess negative impact. Therefore, a total of 9 criteria are to be evaluated in the TOPSIS analysis in this study.

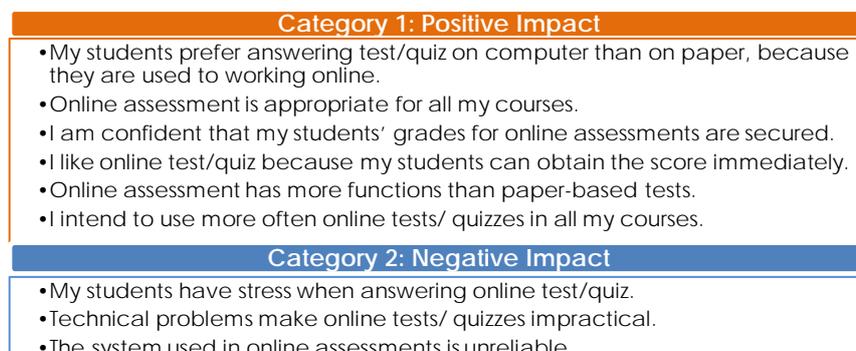


Figure 1: Criteria with positive impact and criteria with negative impact

3.2 Identification of Alternatives for TOPSIS Analysis

TOPSIS method is used to rank a number of alternatives based on the criteria. A total of 31 lecturers who participated in this study are the alternatives to be ranked using the TOPSIS method. Therefore, using the TOPSIS analysis, the lecturers (that are the alternatives) would be ranked according to the acceptance level of using online assessment tool.

4. RESULTS AND DISCUSSION

4.1 Optimal Ranking from TOPSIS Analysis

An evaluation matrix X consists of $m = 31$ alternatives and $n = 9$ criteria is formed. The elements in the matrix X are the responses from the participants. The matrix X is given by

$$X = (x_{ij})_{m \times n} \quad (1)$$

The matrix X is normalised to matrix Z :

$$Z = (z_{ij})_{m \times n} \quad (2)$$

where $z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}$, $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

Then, a weighted normalised decision matrix T is formed:

$$T = (t_{ij})_{m \times n} \quad (3)$$

where $(t_{ij})_{m \times n} = (w_j z_{ij})_{m \times n}$, $\sum_{j=1}^n w_j = 1$, $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

The best condition, A_b , and the worst condition, A_w , are identified:

$$\begin{aligned} A_b &= \{(\min(t_{ij} | i = 1, 2, \dots, m) | j \in J_-), (\max(t_{ij} | i = 1, 2, \dots, m) | j \in J_+)\} \\ &\equiv \{t_{bj} | j = 1, 2, \dots, n\} \end{aligned} \quad (4)$$

$$\begin{aligned} A_w &= \{(\max(t_{ij} | i = 1, 2, \dots, m) | j \in J_-), (\min(t_{ij} | i = 1, 2, \dots, m) | j \in J_+)\} \\ &\equiv \{t_{wj} | j = 1, 2, \dots, n\} \end{aligned} \quad (5)$$

where J_+ associates with the criteria having positive impact, that are the criteria in the Category 1, and J_- associates with the criteria having negative impact, that are the criteria in the Category 2. The criteria are given in Figure 1.

The relative closeness to the ideal solution, S_{iw} , is obtained by using the following equation:

$$S_{iw} = \frac{d_{iw}}{d_{ib} + d_{iw}} \quad (6)$$

where $d_{ib} = \sqrt{\sum_{j=1}^n (t_{ij} - t_{bj})^2}$, $d_{iw} = \sqrt{\sum_{j=1}^n (t_{ij} - t_{wj})^2}$, and $0 \leq s_{iw} \leq 1$, $i = 1, 2, \dots, m$.

In this study, the values of S_{iw} that are obtained from the calculation using equations (1) to (6) are shown in Table 1.

In TOPSIS, the relative closeness to the ideal solution, S_{iw} , is an indicator that associates with each alternative. Ranking of the alternatives can be made based on this indicator. The values of the relative closeness to the ideal solution, S_{iw} , are between 0 and 1. The alternative with the value of 0 represents the worst candidate while the alternative with the value of 1 represents the best candidate. The values of S_{iw} given in Table 1 are the indicators associated with each lecturer participated in the study. In TOPSIS, an alternative with the largest value of S_{iw} showing that the alternative meets the criteria with the most positive impact in the first category and has the least negative impact on those criteria in the second category. Thus, an optimal ranking is obtained based on the descending values of S_{iw} . Therefore, the optimal ranking of the lecturers that is shown in Table 1 represents the ranking of lecturers according to the acceptance level of using online assessment.

Table 1: Optimal Ranking from TOPSIS Analysis

Lecturer ID	S_{iw}	Rank	Lecturer ID	S_{iw}	Rank
1	0.6368372	6	17	0.4032826	23
2	0.6480074	2	18	0.2927644	28
3	0.4982076	11	19	0.4138552	22
4	0.5214050	9	20	0.6363079	7
5	0.4856631	13	21	0.2567573	30
6	0.6400050	5	22	0.3870261	24
7	0.6631897	1	23	0.4909138	12
8	0.2283392	31	24	0.6422003	4
9	0.4407712	18	25	0.4166003	21
10	0.4471179	17	26	0.3742617	25
11	0.4181615	20	27	0.2911140	29
12	0.4856228	14	28	0.5122031	10
13	0.4636676	15	29	0.6444539	3
14	0.4401929	19	30	0.4594815	16
15	0.5708377	8	31	0.3338589	27
16	0.3469635	26			

4.2 Analysis on the Optimal Ranking from TOPSIS

After the optimal ranking from TOPSIS analysis is obtained, the acceptance level of using online assessment among the lecturers participated in this study is further analyzed according to the demographic profile of the respondents. For the purpose of this study, the values of S_{iw} are arranged in descending order. In this way, the ranking of acceptance level using online assessment among the lecturers is produced. The ranking of the respondents that fall under first half of ranking (that is from rank 1 to 16) shows that the acceptance level of using the online assessment is higher. On the other hand, the ranking of the respondents that fall under lower half of ranking (that is from rank 17 to 31) shows that the acceptance level of using the online assessment is lower.

4.2.1 TOPSIS Analysis According to Field of Study

Table 2 shows that a high percentage of lecturers in the field of Computer Science (83%) fall under first half of ranking. The background of this group of lecturers could be the contributing factor to the high acceptance level of using online assessment. The results indicate that the

distribution of Mathematics lecturers in the ranking is disperse where almost half of them (47%) fall under first half of ranking and the other half (53%) fall under lower half of ranking. The optimal ranking from the TOPSIS analysis shows that the acceptance towards online assessment among the Statistics lecturers is not very high as 67% of them fall under lower half of ranking.

Table 2: Ranking Acceptance Level According to Field of Study

Field of Study	Ranking from TOPSIS Analysis (Rank 1-16)		Ranking from TOPSIS Analysis (Rank 17-31)	
	Frequency	Percent	Frequency	Percent
	Computer Science	5	83%	1
Mathematics	9	47%	10	53%
Statistics	2	33%	4	67%

4.2.2 TOPSIS Analysis According to Age and Years of Teaching Experience

The analysis on the ranking from TOPSIS according to age and years of teaching experience of the respondents is shown in Table 3 and Table 4, respectively. It shows that most young lecturers with fewer years of teaching experience (83%) fall in the lower half of ranking. This shows that their perception on online assessment is not very positive. This phenomenon might be due to the insufficient exposure on adopting technology in conducting assessment, lack of initiative or courage to try on new method of testing and lack of training on using i-Learn system.

Table 3: Ranking Acceptance Level According to Age

Age	Ranking from TOPSIS Analysis (Rank 1-16)		Ranking from TOPSIS Analysis (Rank 17-31)	
	Frequency	Percent	Frequency	Percent
	Below 30 years old	1	17%	5
31 - 40 years old	9	56%	7	44%
41 - 50 years old	3	60%	2	40%
51 years old and above	3	75%	1	25%

However, online assessment is well-received by the elder lecturers who have longer years of service in the teaching career. Table 3 shows that 75% of lecturers who are 51 years old and above fall into first half of ranking. Table 4 shows 67% of lecturers who have at least 11 years of teaching experience fall into first half of ranking. Although it is common to believe that younger generation is more technology-savvy or Internet savvy, the findings in this study show that the experienced lecturers see the advantages of online assessment and are more willing to adopt the new way of conducting assessment using technology.

Table 4: Ranking Acceptance Level According to Years of Teaching Experience

Years of Teaching Experience	Ranking from TOPSIS Analysis (Rank 1-16)		Ranking from TOPSIS Analysis (Rank 17-31)	
	Frequency	Percent	Frequency	Percent
5 years and below	1	17%	5	83%
6 - 10 years	9	56%	7	44%
11 years and above	6	67%	3	33%

4.2.3 TOPSIS Analysis According to Gender

The statistics in Table 5 show that most of the male lecturers (71%) fall into higher ranking from TOPSIS analysis while 54% of female lecturers fall into lower ranking from TOPSIS analysis. It shows that male lecturers generally acquire better skills in technology and assess technology more often than female lecturers. The women usually reluctant to spend time in learning on how to use new technology because they have other commitment besides career. However, the reservations on the use of technology among most female lecturers are often a symptom of anxiety or incompetence in the skills to use computer and technology [14]. Hence, the acceptance on technology as well as online assessment among female lecturers could be increased once they are given sufficient training on the computer technology.

Table 5: Ranking Acceptance Level According to Gender

Gender	Ranking from TOPSIS Analysis (Rank 1-16)		Ranking from TOPSIS Analysis (Rank 17-31)	
	Frequency	Percent	Frequency	Percent
Male	5	71%	2	29%
Female	11	46%	13	54%

5. CONCLUSION

There are two main findings in this paper. First, the paper presented an analytical approach of applying TOPSIS in analysing data collected using questionnaire. The items in questionnaire should include both positive impact and negative impact. The optimal ranking obtained from TOPSIS analysis is further analysed according to the profiles of the alternatives. The approaches presented in this paper could be served as a reference for future researches that involve data collection using questionnaire. Second, the application of TOPSIS in this paper involves a study aim at investigating the acceptance level of online assessment among the lecturers in the university. The analysis using TOPSIS method successfully produced the ranking of the lecturers based on their acceptance level of using online assessment.

From the analysis of optimal ranking from TOPSIS, it shows that most of the lecturers in the field of Computer Science have higher acceptance level towards online assessment compared to their peers who are in the field of Mathematics and Statistics. However, younger lecturers

with less experience in teaching have lower acceptance level of using online assessment. The optimal ranking obtained from the TOPSIS analysis shows that most lecturers who have longer years of service in teaching career and elder lecturers have better perception of online assessment. Overall, the concept of online assessment is well-received by most male lecturers compared to female lecturers. Although the scope of this study is limited to the lecturers in the field of Computer Science, Mathematics and Statistics, the methodology used in this study could be applied to a broader range of lecturers with different fields of study. The results of the analysis could help administration in university to understand the acceptance level of using online assessment among the lecturers with different demographic profile. The ranking of the lecturers may also help the administration to identify who need to attend professional development program in order to increase their acceptance level of using online assessment. With a more specific targeted group of participants, the effectiveness of the program could be increased. The targeted group of lecturers who are identified to attend the program could also benefit tremendously from the program.

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