Selection between AHP and TOPSIS for Academic Information Systems Decision Making Model

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Keywords: Academic Information System, Open Source, MADM, AHP, TOPSIS.

Abstract: One way to develop a system of academic information using applications Free Open Source (FOS) that are circulating. Academic information system developers need to determine the appropriate FOS used to develop academic information system based on the criteria required and reliability of FOS. One way to help decision-making can be used MADM models using AHP and TOPSIS. In this study, applying a comparative analysis of the two methods, the method of AHP and TOPSIS with analytical testing calculations used to compare the three-applications FOS Academic Information System, Campus Academic Information System (Siakad), Academic Information Systems Integrated (Sikadu), as well as SISFOKOL to develop academic information systems.

1 INTRODUCTION

Technological developments have an impact on university academic services. At first, the academic service is only done by hand using paper media and stationery (display devices), with the growing scale of academic service which means user can no longer do, many universities use Microsoft Office applications to perform academic services but each university institution has its own characteristics so that the necessary academic service system is unique academic information in accordance with the needs of each university. To develop an academic information system application do not require large funds to the presence of Free Open Source (FOS). FOS helping universities realize the management of information technology-based academic services without thinking about software procurement funds (Rousidis and Christodoulou, 2019), FOS can be developed and modified freely adapted to the needs.

It is necessary to pay more attention to determining FOS according to the needs of each university and its reliability because each FOS has advantages and disadvantages. In determining the most appropriate FOS needs and can reliably use the technique of decision-making methods Multiple Attribute Decision Making (MADM), including Simple Additive Weighting (SAW), Weight Product (WP), TOPSIS, and AHP methods (Kazimieras Zavadskas et al., 2019), This study using AHP and TOPSIS later than the methods are superior and relevant to the research problems.

AHP is a multi-criterion that can perform decision-making process with many criteria (Terzi, 2019). AHP superiority compared to other MADM models are able to analyze simultaneously as well as integrated between quantitative and qualitative criteria (Distel, 2018). AHP can help facilitate decision-making by many criteria. Research using AHP previously been done in the manufacture and analysis of the rector election system by using AHP (Fitriastuti et al., 2019), Other studies of AHP has done research on the selection of open source digital library applications using AHP with three open source alternatives.

In addition to the AHP, TOPSIS can also perform multi-criteria decision-making (Distel, 2018) to provide a solution by comparing each alternative with the best and worst alternative (Fitriastuti et al., 2019). TOPSIS widely used on the grounds concept is simple, easy to understand computation, efficient, and have the ability to measure the relative performance of alternatives in the decision of a simple mathematical form (Distel, 2018). Research by TOPSIS method was made for selecting suppliers in the pharmaceutical distribution industry method approach (Putra and Sylvandinata, 2019).

Putra, J., Rakhman, T. and Biddinika, M.
Selection between AHP and TOPSIS for Academic Information Systems Decision Making Model.
DOI: 10.5220/0009878700860089
In *Proceedings of the 2nd International Conference on Applied Science, Engineering and Social Sciences (ICASESS 2019)*, pages 86-89
ISBN: 978-989-758-452-7

The problem is how to find a better model of AHP or TOPSIS in decision making of academic information systems at Department of Informatics Engineering Universitas Janabadra. So, the goal is to produce the right solution in selecting the appropriate FOS and more relevant to know the method used in this case between the AHP and TOPSIS methods.

2 MANUSCRIPT PREPARATION

Following a decision support system theory MADM models used in this study:

2.1 Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a functional hierarchy to the main input of human perception. Method was developed to search for a rank (priority) of the various alternatives in solving a problem (Escolar et al., 2019). AHP in resolving problems with some design principles, which must be understood, such as (Maxwell, 2019); (1) Creating a hierarchy, (2) Assessment criteria and alternatives, (3) Synthesis of Priority (Setting priorities), and (4) Logical consistency.

2.2 AHP Steps

There are several steps in the completion of the AHP method, as follows (Gürbüz, 2019):

1. Defining the problem and determine the desired solution, then hierarchical structuring.
2. Prioritization; (a) the contribution size of each element to achieve the goal, (b) compiled by the relative level of interest of each element, (c) summing columns, (d) creating a new matrix by means of each element divided by the number of columns, (e) summing lines, (f) creating a new matrix with elements result the number of rows divided by the total sum. The results of the final division called Eigen Vector.
3. Logical consistency Consistency means two things: first that thought or similar objects are grouped according to homogeneity and relevance. The second meaning is that the consistency of the intensity of the relationships between ideas or objects based on a certain criterion to justify each other logically; (a) create new matrix by multiplying the initial matrix with Eigen Vector, (b) add up in rows, (c) for the sum with Eigen Vector, the division called Eigen Value, (d) Count the ways by; (i) add up by Eigen Value, (ii) the sum is divided by the order, then the result is called a lambda max or t, (iii) calculate CI (Consistency Index), (iv) calculate CR (Consistency Ratio)
4. Rin is the Random Index. Random Index (RIN), also called Random Consistency (RC) (Gürbüz, 2019) during the CR value does not exceed 10%, or 0.10, the value given paired comparisons are considered consistent.
5. Priority calculate Alternatives There are two types of data on the alternative, namely the qualitative as well as quantitative data types. The calculating a priority of these two data types are different, the qualitative data is by comparing each alternative. Comparisons were by pairwise comparison matrix similar to determining the priority criteria in step number two above. Quantitative data on the priority type depends on the type of criteria (sub-criteria), namely, the cost (cost) and gain (benefit) ((Distel, 2018).

2.3 Stage Data Collection

Collecting data is through observation and literature study. The observations were to collect data and information, as well as exploring and comparing the system, interviews were conducted with the management of the department, a literature study is to understand the application well as understand the concept of the application of AHP and TOPSIS via the internet, papers, journals, and books that are relevant.

2.4 Preliminary Analysis Phase

Initial analyzes do an analysis of the criteria and the application of methods in selecting the FOS for the development of academic information systems (Uskov et al., 2017) . There are two application methods in this case is the method of AHP and TOPSIS. Then they will be compared to find more relevant method used to select the appropriate FOS.

2.5 Testing Phase

The testing phase is done by analyzing the comparative analysis with conformity to calculate the degree of conformity (Tki) on each method using the formula: -

$$Tk_i = \frac{Xi}{DataFADM(100\%)} \tag{1}$$

Where Tki = Suitability, Xi = average scores of data methods. Looking Xi using the formula:

$$X_i = \frac{\Sigma DataAHPorTOPSI}{n} \quad (2)$$

Concordance rate is measured by the percentage level at Table 1.

Table 1: Table Percentage level of concordance

The percentage rate of conformity	Category
31% - 45%	Unsatisfactory / no good
46% - 60%	Unsatisfactory / poor
61% - 75%	Quite satisfactory / good enough
76% - 85%	Satisfactory / good
86% -100%	Very satisfactory / good

3 RESULT AND DISCUSSION

The initial phase of the analysis is to describe the alternative open source applications are required selection criteria to give weight to the criteria in order of importance and needs. As an alternative application is given as follows; (1) Campus Academic Information System (Siakad), (2) Integrated Academic Information System (Sikadu), (3) SISFOKOL.

Six criteria were used here; features, technology, source code program, flexibility and support the developer. Each criterion is determined whether the nature of cost/benefits, costs mean less value the good, while the profits instead. On the criteria here, all categorized advantage. Furthermore, each criterion is weighted based on the results of the third exploration application, interview-related needs, and interview some expert programmers, further testing using AHP and TOPSIS.

3.1 Calculation Method of AHP

In the hierarchy there are six main criteria of Ease (Kem), Features (Fit), Source Code (Sourc), Flexibility (Fleks), as well as support the Developer and the Community (Duk).

Step 1. Develop a pairwise comparison matrix using the concept of Saaty intensity scale, as shown in Table 2.

Table 2: Pairwise Comparison Matrix

Criteria	Kem	Fit	Tek	sourc	reflex	kerchief
Kem	1	3	3	1	4	3
Fit	0.33	1	1	0.33	3	1
Tek	0.33	1	1	0.33	3	1
sourc	1	3	3	1	4	3
reflex	0.25	0.33	0.33	0.25	1	0.33
kerchief	0.33	1	1	0.33	3	1
total	3.24	9.33	9.33	3.24	18	9.33

Step 2. Normalization of each column (A') and calculating the average of each row (W).

a) Normalization of each column (A'), each entry matrix divided by the total number of columns.
b) Calculating the average of each row (W). The average of each row of the matrix entries and the results are expressed as a priority vector.

Step 3. Calculate the consistency index (CI): count (A) (W^t)

CR = 0.0162 / 1.24 = 0.0131

CR $<$ 0.1, so consistent.

CR = 0.0162 / 1.24 = 0.0131 CR $<$ 0.1, so consistent.

Step 5. Ranking of the calculation based on the weight of each criterion, do multiplication weighting each criterion to the weights of the level of interest among the criteria. The results can be seen in Table 3.

Table 3: Ranking of results tables

	Result	Rank
SISFOKOL	.2495	3
Sikadu	.3262	2
Siakad	.3514	1

3.2 Calculation Method of TOPSIS

Step 1. Determine the importance scale of each criterion (C1), features (C2), technology (C3), program source code (C4), flexibility (C5), developer and community support (C6), rated on a scale up to five and decision makers give preference to weight on the same scale. The results can be seen in Table 4.

Table 4: Scale the importance of each criterion

Alternative	Criteria					
	1	2	3	4	5	6
Siakad						
Sikadu						
SISFOKOL						

Step 2. Normalize matrix (R) decision.

Step 3. Calculation of weighted normalized matrix (Y), that is by multiplying the normalized matrix (R), by weighting preference (W)

Step 4. Determine the positive ideal solution (A+) and the ideal negative solution (A-)

Step 5. Determine the distance between the weighted values of each alternative to the ideal positive solution (Si+) and the ideal negative (Si-) solution.

Step 6. Calculate the proximity of each alternative to the ideal solution Analysis of AHP calculations and TOPSIS.

Criteria ranking is determined based on rules that have the highest weight value are in the first priority to be chosen and occupy the first rank. Sequential ranking starts from the criteria having the largest to the smallest weight value. The results of ranking with the AHP and TOPSIS methods can be seen in the following Table 5:

Table 5: AHP and TOPSIS ranking

Alternative	Weight value		AHP ranking	TOPSIS ranking
	AHP	TOPSIS		
Siakad	0,3514	0,7228	1	1
Sikadu	0,3262	0,3741	2	4
SISFOKOL	0,2495	0,5728	3	2

Based on the table above, an analysis is conducted to find out the relevant methods for the problem by calculating the level of suitability (Tki) of each method. To find out the results of the level of conformity (Tki), the first step is to find out the average value in each method. calculated using the following formula:

$$Xi_{AHP} = \frac{1,1005}{4} = 0,275125$$

$$Xi_{TOPSIS} = \frac{2,217}{4} = 0,53175 \quad (3)$$

4 CONCLUSIONS

Based on the results of a comparison analysis between the level of conformity (Tki) of AHP method and TOPSIS, both methods are in a very satisfying range in assisting decision making in the MADM model but for cases that use qualitative data and multicriteria AHP method is more suitable to use than TOPSIS. The ranking results using the AHP and TOPSIS methods are the same in rank 1 category, but different in the next ranking. Siakad can be taken as FOS to develop academic information systems. The AHP method has a higher level of suitability than the TOPSIS method, so the use of the AHP method is more relevant to the problem and can be used as one of the decisionmaking models for the MADM application that best meets the criteria. This research still has deficiencies in terms of determining the weight of criteria and determining the level of importance because it is still based on the perceptions of decision makers obtained from interviews and some experts in their fields are not based on processing the results of the questionnaire.

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