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Research Paper

The Implementation of Multi-Objective Optimization on the Basis of Ratio Analysis Method to Select the Lecturer Assistant Working at Computer Laboratorium

Tonni Limbong[1*], Janner Simarmata[2], S Sriadhi[2], A R S Tambunan[2], Enny Keristiana Sinaga[2], Naeklan Simbolon[2], H M P Simarmata[3], A L S Siahaan[4], Indira Ruth Septarini[5], Indra Kelana Jaya[6], Maulana Arafat Lubis[7], Ilham Khairi Siregar[8], Henry Kristian Siburian[9], Agung Purnomo[10], Fatkul Anam[11], Delyanti Azzumarito Pulungan[12], Parulian Siagian[13], Parasian DP Silitonga[1], Romanus Damanik[1], Sorang Pakpahan[1]

[1]*Universitas Katolik Santo Thomas, Medan, Indonesia*
[2]*Universitas Negeri Medan, Medan, Indonesia*
[3]*Politeknik Bisnis Indonesia, Siantar, Indonesia*
[4]*Universitas Pelita Harapan Medan, Medan, Indonesia*
[5]*Institut Sains dan Teknologi TD. Pardede, Medan, Indonesia*
[6]*Universitas Methodist Indonesia, Medan , Indonesia*
[7]*IAIN Padangsidimpuan, Indonesia*
[8]*Universitas Muhammadiyah Sumatera Utara, Medan, Indonesia*
[9]*STMIK Budidarma Medan, Medan, Indonesia*
[10]*Bina Nusantara Institute of Creative Technology Malang, Malang, Indonesia*
[11]*Universitas Wijaya Kusuma Surabaya, Surabaya, Indonesia*
[12]*Universitas Prima Indonesia, Medan, Indonesia*
[13]*Universitas HKBP Nommensen, Indonesia*
**Corresponding author E-mail: tonni.budidarma@gmail.com*

Abstract

A lecturer assistant is expected to be professional when dealing with the score or decision. Being professional, the lecturer assistant will be constantly respected by the students. The lecturer assistant should be able to make use of the time to keep the disciplinary. Selecting and determining the lecturer assistant at Computer Science of Unika St. Thomas Medan are conducted by the phases of selecting and taking value of the test score, the semester of lecturer assistant candidate, the number of classes to be assisted, cumulative grade point achievement, and the score of the assisted course. The Method of Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) is in the part of Decision Support System introduced by Brauers dan Zavadkas. This method is the multi-objective optimization technique which is successfully applied to solve the various complicated decision-making and well-used in terms of lecturer assistant selection due to its simple calculation and easiness to understand.

Keywords: *Lecturer assistant, Decision Support System, MOORA Method*

1. Introduction

In the teaching and learning at the university, the lecturers are super busy since they have to do the *Tridarma* of higher education. This condition, of course, makes the lecturers need the lecturer assistant to be able to have still a contact with the students while they cannot attend the class. The lecturer assistant assuredly is closer to the students for they are quite the same in terms of the age. In addition, the lecturer assistant is still at the university as a student. Even though they are closer, he/she is not allowed to liberate the students to prevent the less responsibility towards the course offered. The lecturer assistant usually works at the computer laboratory or fulfills the lecturer's vacant teaching hours. The lecturer assistant is obliged to prepare all equipment before the course activities start. The lecturer assistant is a student who has definite qualifications who passes several stages of selection from certain institution especially the requirements from the lecturers.

Having many students who possess the excellent competency, especially in mastering the computer laboratories while the amount of the lecturer assistant required is limited, therefore the selection process is complicated in selecting the right person to be the lecturer assistant [1][2]. It requires an instrument to measure as the decision system [3]–[6].

Multi-Objective Optimization on the Basis of Ratio Method (MOORA) is a method which has a decision support system introduced by Braurers and Zavadkas [7]. It is exemplary used in selecting the lecturer assistant since it has a convenient calculation and is straightforward to understand. The MOORA Method is a multi-objective one that is successfully applied to solve the complex decision making[8]. The basic concept of MOORA system is its ability to calculate on the input variable based on the vagueness value. In the theory of the cryptic set, it is ex-

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pressed that something can be said partly true and false at the same time.

2. Research Method

The research method used in this application creation is *System Development Life Cycle* (SDLC). This method is a series activities conducted by the professional and information system user to develop and implement the application [9][10]. The phases of SDLC approach are:

a. System plan phase, in this phase, data collection is conducted, and then determines how the system can solve the existing problems.
b. Analysis phase, this analysis phase is done by analyzing the system required to determine the criteria of lecturer assistant such as data analysis, problem identification, and system analysis.
c. Design phase, it is conducted by two stages: (1) Data base design. This design is conducted by creating the table and data structures related to the database. (2) System design in general. At this phase, it is organized the plan of flowchart system procedures in data flow diagram and flowchart system.
d. Implementation phase, it is conducted after the design phase has been completely done. Then, the creation stage is done in programming language. The programming language used is PHP and HTML, while MySQL becomes the database [9].
e. Trials phase, trials system is a test conducted after the system creation has been done by having the experiment on the user interface.
f. Usage phase (Maintenance system phase), the usage phase is a phase where the system has been designed and then successfully through the trials phase and then it can be used.

3. MOORA Framework

The MOORA method is a relatiely new method introduced first by Brauers in a multi-criteria retrieval. MOORA's methods are widely applied in areas such as management, construction, road design, and the economy[7]. This method has a good level of selectivity in determining an alternative. MOORA's approach is defined as a process simultaneously to optimize two or more conflicting on some constraints[11]. The MOORA method has a level of flexibility and ease of understanding in separating the subjective part of an evaluation process into the decision-making criteria with some decision-making attributes[12]–[14]. This method has a good selectivity level because it can determine the purpose of conflicting criteria which can be beneficial (benefit) or unprofitable (cost)[15]–[17]. Problem solving steps using MOORA method are:

a. Matrix formation

$$x = \begin{bmatrix} x_{11} & x_{12}.. & x_{1n} \\ x_{21} & x_{22}.. & x_{2n} \\ x_{m1} & x_{m2}.. & x_{mn} \end{bmatrix}$$

x is the criterion value of each that is represented as a matrix.

b. Determining the normalization matrix

$$x_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^2}}$$

The Xij ratio shows the i [th] size of the alternatives on the criterion to j, m, and then denotes the number of alternate and n denotes the number of criteria. Brauers concluded that the denominator is the best choice of the square root of the sum of squares of each alternative per criterion [7].

c. Determining the weight normalization matrix
$W_j X_{ij}$
In some cases, it is often observed that some criteria are more important than others. To indicate that a criterion is more important, it can be multiplied by an appropriate [7]. Where Wj is the weight of the j th criterion.
d. Determining the preference value

$$yi = \sum_{j=1}^{g} w_j x_{ij} - \sum_{j=g+1}^{n} w_j x_{ij}$$

In terms of multi-objective optimization, the result of normalization is the summation in terms of maximization (from favorable attributes) and reduction in terms of minimization (from unfavorable attributes) where g is the number of attributes that will be maximized, yi is the value of the normalized normalization assessment against all the criteria. The yi value can be positive or negative depending on the maximum number (benefit criteria) and minimal (unfavorable or cost criteria) in the decision matrix. A privilege yi shows the final preference. Thus, the best alternative has the highest yi value, while the worst alternative has the lowest yi value.

4. Results and Discussion

To select the lecturer assistant in the laboratory and to get the best decision at the Computer Science Faculty of St. Thomas Catholic University of Medan still occupies the manual way, that is by collecting the value of each selection stage in determining who is the feasible and best in accordance with the alternatives that have been determined, then proceed with analyzing and calculating the results and matching them to the certain standard values and criteria. The process in each of these stages makes it difficult for the assessment team to select since the process takes a long time to analyze in determining who is worthy and best among all the participants.

4.1. The Steps of MOORA Method

The process of utilizing the method is illustrated to describe the problem-solving steps as shown by the following figure :

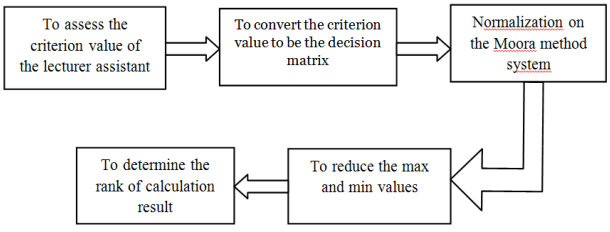


Fig.1: The steps of MOORA Method

Manual recruitment procedures for lecturer assistant are made to perform the process of recruitment of lecturer assistant in the Faculty of Computer Science. The recruitment of lecturer assistant is conducted as a medium to find the assistant of teaching and learning activities in the Faculty of Computer Science. Parties / Functions related to the achievement of academic quality standards are: Dean of Faculty, Head of Study Program / Secretary of Study Program, Head of Laboratory, Faculty of Computer Science, Lab Officer, Lecturer (Lecturer Examiner), Student.

4.1.1 General Requirements:

a. The Dean assigns the Head of Study Program to determine the recruitment time of the assistant lecturer, along with the course and the number of assistants needed to be coordinated with the Head of Laboratory.

b. Head of Laboratory Faculty of Computer Science to make a plan of acceptance of assistant lecturer which contains about preparation plan, registration, test execution, and announcement of result.
c. Lecturer examiners are lecturers who are given the task of testing and provide an assessment of the students who enroll into prospective lecturer assistant in accordance with the related field of science.
d. The administrative staff of the recruitment of lecturers' assistants is the laboratory staff assigned to perform the management procedures. These lab personnel are responsible for the initial screening of student enrollment files.
e. Students who will register as prospective lecturers are required to collect the files as required and fill out the registration form.
f. Requirements to become a prospective lecturer assistant are:
   1) Minimal semester IV (four)
   2) The related courses (those in Assistance) are at least B
   3) Minimum GPA 3.00
   4) For practicum System, is expected to master the database
   5) Collecting CV Transcripts, KTM 1 sheet, Photo 3x4 (2 pieces, red background wear alma mater suit)

4.1.2 Implementation Procedures

a. Head of Laboratory Faculty of Computer Science announced recruitment of assistant lecturers
b. Prospective Assistants submit applications submitted directly to the lab officer of the Faculty of Computer Science.
c. The lab officer selects the administration of all application files to the Lab. Faculty of Computer Science.
d. The lab officer announces the candidate who passed the initial selection (administrative selection) on the bulletin board.
e. For candidates who pass the initial selection (administrative selection) are entitled to follow the next stage of testing is Micro Teaching (Test teaching) in accordance with the courses that he chose and in accordance with the time set by the Lab. Faculty of Computer Science.
f. Selection Team consisting of lecturers Department of Faculty of Computer Science who has been appointed by the Head of Study Program and known by the Dean of the Faculty of Computer Science to assess in accordance with the existing assessment criteria.
g. Selection results will be announced no later than 1 week after the second stage selection process is conducted.

4.2. Criteria Determination

MOORA method requires criteria that will be used as calculation materials in the ranking process. The criteria considered by the best lecturers' selection committee [6] as shown in table 1.

Table.1: Criteria Determination

Criteria	Description
C1	Test Score
C2	Prospective Assistant Semester
C3	The Amount Class to be Assisted
C4	Grade Point Average (GPA)
C5	The Assisted Course Score

The criteria used in the selection of assistant lecturers using MOORA method with weighting as in table 2 below:

Table .2: Criteria Weight

No	Criteria	Range / Value	Weight Value
1	Test score (C1)	>=70 and <=80	1
		>80 and <=90	2
		>90	3
2	Semester (C2)	3-4	3
		5-6	2
		7-8	1
3	The Amount Class to be Assisted (C3)	1-2	3
		2-4	2
		>4	1
4	GPA (C4)	>=3,0 – <=3,3	1
		=>3,3 – <=3,5	2
		>3,5	3
5	The Assisted Course Score (C5)	B	1
		B+	2
		A	3

4.3 Data of Prospective Lecturer Assistant

Based on the data of Assistant Lecturer at the Faculty of Computer Science of St. Thomas Catholic University of Medan, 10 people are taken as the best candidate for Assistant Lecturer, Data from each candidate in Table 3 below.

Table.3: Data and score of prospective lecturer assistant

No.	Candidate	Score of Prospective Lecturer Assistant				
		Test score	Semester	The Amount Class to be Assisted	GPA	The Assisted Course Score
1	Mixo	83	4	4	3.75	A
2	Fran	85	6	3	3.6	A
3	Abdul	78	4	3	3.30	B+
4	Deddy	78	5	3	3.2	B+
5	Adi Buaton	83	5	4	3.54	B
6	David	82	6	4	3.33	A
7	Matilda	84	5	3	3.4	A
8	Olivia	84	5	3	3.6	B+
9	Hery	79	4	3	3.5	A
10	Oktariani	80	4	3	3.3	A

4.4 Matrix Formation

The matrix formation of score data from the prospective lecturer assistant in accordance with the value of weight as can be seen from the following table 4:

Table.4: Score Matrix

Alternative	C1(+)	C2(+)	C3(+)	C4(+)	C5(+)
A1	2	3	1	3	3
A2	2	2	2	3	3
A3	1	3	2	1	2
A4	1	2	2	1	2
A5	2	2	3	3	1
A6	2	2	3	2	3
A7	2	2	2	2	3
A8	2	2	2	3	2
A9	1	3	2	2	3
A10	1	3	2	1	3

4.5 Determining the Normalization Matrix

The normalization process aims to unify each element of the matrix so that the elements in the matrix have a uniform value. Normalization on MOORA is calculated by the sample value data from the following steps:

1. The process of determining the matrix normalization of criteria C1

$$x_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^2}}$$

$$X1,1 = \frac{X1,1}{\sqrt{X11^2 + X12^2 + X13^2 + X14^2 + X15^2 X16^2 + x17^2 + X18^2 + X19^2 + X10^2}}$$

$$x_{1,1} = \frac{2}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.07143$$
$$x_{2,1} = \frac{2}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.07143$$
$$x_{3,1} = \frac{1}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.03571$$
$$x_{4,1} = \frac{1}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.03571$$
$$x_{5,1} = \frac{2}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.07143$$
$$x_{6,1} = \frac{2}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.07143$$
$$x_{7,1} = \frac{2}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.07143$$
$$x_{8,1} = \frac{2}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.07143$$
$$x_{9,1} = \frac{1}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.03704$$
$$x_{10,1} = \frac{1}{\sqrt{2^2+2^2+1^2+1^2+2^2+2^2+2^2+2^2+1^2+2^2}} = 0.03704$$

2. The process of determining the matrix normalization criterion C2

Here is the process of calculating the matrix for work quantity criteria

$$Xi,j = \frac{\text{Xi, j}}{\sqrt{\text{X11}^2 + \text{x12}^2 + \text{X13}^2 + \text{X14}^2 + \text{X15}^2\text{X16}^2 + \text{x17}^2 + \text{X18}^2 + \text{X19}^2 + \text{X10}^2}}$$
$$x_{2,1} = \frac{3}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.05000$$
$$x_{2,2} = \frac{5}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.03333$$
$$x_{3,2} = \frac{2}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.05000$$
$$x_{4,2} = \frac{3}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.03333$$
$$x_{5,2} = \frac{2}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.03333$$
$$x_{6,2} = \frac{2}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.03333$$
$$x_{7,2} = \frac{2}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.03333$$
$$x_{8,2} = \frac{2}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.03333$$
$$x_{9,2} = \frac{3}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.05882$$
$$x_{10,2} = \frac{3}{\sqrt{3^2+2^2+3^2+2^2+2^2+2^2+2^2+2^2+3^2+3^2}} = 0.05882$$

In the same way up to i = 5 it will form a table of normalization matrices presented in the form of table 5 below

Table.5: Normalization Matrixes

Alternative	C1	C2	C3	C4	C5
A1	0.07143	0.05	0.02128	0.05882	0.04478
A2	0.07143	0.03333	0.04255	0.05882	0.04478
A3	0.03571	0.05	0.04255	0.01961	0.02985
A4	0.03571	0.03333	0.04255	0.01961	0.02985
A5	0.07143	0.03333	0.06383	0.05882	0.01493
A6	0.07143	0.03333	0.06383	0.03922	0.04478
A7	0.07143	0.03333	0.04255	0.03922	0.04478
A8	0.07143	0.03333	0.04255	0.05882	0.02985
A9	0.03704	0.05882	0.04651	0.04	0.05172
A10	0.03704	0.05882	0.04651	0.02	0.05172

4.6. Determining the Weight Normalization Matrix

The below is the percentage value of each eligibility criteria as in table 6 below:

Table.6: Weight Criteria

No	Criteria	Percentage
1	Test score	0,22
2	Semester	0,15
3	The Amount Class to be Assisted	0,18
4	GPA	0,24
5	The Assisted Course Score	0,21

To determine the weighted normalization matrix, using equation (2.3). The value of the normalization matrix for the selected sample is based on Table 5. And the weighting value of the criteria is based on Table 6, so that the results as shown in table 7 are as follows:

Table.7: Determine the weighted normalization matrix

Alternatives	C1 * 0.22	C2 * 0.18	C3*0.18	C4*0.24	C5 * 0.21
A1	0.01571	0.00750	0.00383)	0.01412	0.00940
A2	0.01571	0.00500	0.00766)	0.01412	0.00940
A3	0.00786	0.00750	0.00766)	0.00471	0.00627
A4	0.00786	0.00500	0.00766)	0.00471	0.00627
A5	0.01571	0.00500	0.01149)	0.01412	0.00313)
A6	0.01571	0.00500	0.01149)	0.00941	0.00940)
A7	0.01571	0.00500	0.00766)	0.00941	0.00940)
A8	0.01571	0.00500	0.00766)	0.01412	0.00627)
A9	0.00815	0.00882	0.00837)	0.00960)	0.01086)
A10	0.00815	0.00882	0.00837)	0.00480)	0.01086)

4.7 Determining the Preferences Value

The last step of the process is to do the calculation for each preference value and do the sorting, using the following formula:

$$yi = \sum_{j=1}^{g} w_j x_{ij} - \sum_{j=g+1}^{n} w_j x_{ij}$$

yA_1 = (0.01571+0.00750+0.00383)-(0.01412+0.00940)= 0.00352
yA_2 =(0.01571+0.00500+0.00766) – (0.01412+0.00940)= 0.00485
yA_3 = (0.00786+0.00750+0.048319) –(0.00471+0.00627)= 0.01204
yA_4 =(0.00786+0.00500+0.00766) –(0.00471+0.00627)=0.00954
yA_5 =(0.01571+0.00500+0.01149)-(0.01412+0.00313) =0.01495
yA_6 =(0.01571+0.00500+0.01149) –(0.00941+0.00940)= 0.01339
yA_7 = (0.01571+0.00500+0.00766)-(0.00941+0.00940) =0.00956
yA_8 = (0.01571+0.00500+0.00766) –(0.01412+0.00627)=0.00799
yA_9 =(0.00815+0.00882+0.00837)-(0.00960+0.01086) =0.00488
yA_{10} =(0.00815+0.00882+0.00837)-(0.00480+0.01086) = 0.00968

From the calculation of preference above then do ranking with table 8 below

Table.8: Calculation of preference

Alternatives	Result
A1	0.00352
A2	0.00485
A3	0.01204
A4	0.00954
A5	**0.01495**
A6	0.01339
A7	0.00956
A8	0.00799
A9	0.00488
A10	0.00968

From the above data calculation results obtained the total value of each participant of the best Lecturer Assistant selection. So that is considered the best worth is the Assistant Lecturer who get the highest score. Based on the calculation of MOORA

method, the highest value of 10 samples taken is 0.01495 ie A5 with the name Adi Buaton.

5. Conclusion

Decision Support System (DSS) Selection of Lecturer Assistant in Computer Laboratory Faculty of Computer Science of St. Thomas Catholic University of Medan built using MOORA method, because it has a very simple calculation and easy to understand so that it can be applied to solve various types of decision-making complex with optimal. The weight used in each criterion is determined by using the rules in the Academic Guidance of Computer Science Faculty of St. Thomas Catholic University of Medan. The trials used in the decision-making system are the correctness, sensitivity and modification of the criteria. The implementation of the correctness test is in accordance with the results obtained. The sensitivity test on the weight value is very sensitive if the weight value changes then the ranking result changes.

References

[1] S. Sriadhi, S. Gultom, R. Restu, and J. Simarmata, "The Effect of Tutorial Multimedia on the Transformator Learning Outcomes Based on the Students ' Visual Ability The Effect of Tutorial Multimedia on the Transformator Learning Outcomes Based on the Students ' Visual Ability," *IOP Conf. Ser. Mater. Sci. Eng. 384 012059*, 2018.

[2] J. Simarmata, "Prototype Application Multimedia Learning for Teaching Basic," vol. 7, pp. 264–266, 2018.

[3] A. S. Ahmar *et al.*, "Lecturers' understanding on indexing databases of SINTA, DOAJ, Google Scholar, SCOPUS, and Web of Science: A study of Indonesians," in *Journal of Physics: Conference Series*, 2018, vol. 954.

[4] A. Yanie *et al.*, "Web Based Application for Decision Support System with ELECTRE Method," *J. Phys. Conf. Ser.*, vol. 1028, no. 1, p. 12054, Jun. 2018.

[5] M. D. T. . Nasution *et al.*, "Decision Support Rating System with Analytical Hierarchy Process Method," *Int. J. Eng. Technol.*, vol. 7, no. 2.3, pp. 105–108, 2018.

[6] T. Suryanto, R. Rahim, and A. S. Ahmar, "Employee Recruitment Fraud Prevention with the Implementation of Decision Support System," *J. Phys. Conf. Ser.*, vol. 1028, no. 1, p. 12055, Jun. 2018.

[7] W. K. M. Brauers and E. K. Zavadskas, "The MOORA method and its application to privatization in a transition economy by A new method : the MOORA method," vol. 35, no. 2, 2006.

[8] P. Karande and S. Chakraborty, "Application of multi-objective optimization on the basis of ratio analysis (MOORA) method for materials selection," *Mater. Des.*, vol. 37, no. 2, pp. 317–324, 2012.

[9] J. Simarmata, A. Djohar, J. Purba, and E. A. Juanda, "Design of a Blended Learning Environment Based on Merrill's Principles," *J. Phys. Conf. Ser.*, vol. 954, no. 1, 2018.

[10] D. Napitupulu *et al.*, "Analysis of Student Satisfaction Toward Quality of Service Facility," *J. Phys. Conf. Ser.*, vol. 954, no. 1, 2018.

[11] M. Chand and T. Raj, "A comparative study of multi criteria decision making approaches for risks assessment in supply chain A comparative study of multi criteria decision making approaches for risks assessment in supply chain Mahesh Chand * and Tilak Raj Ravi Shankar," no. January, 2015.

[12] E. Aytac, "The multi-objective decision making methods based on MULTIMOORA and MOOSRA for the laptop selection problem," no. 2015, 2016.

[13] R. Rahim *et al.*, "TOPSIS Method Application for Decision Support System in Internal Control for Selecting Best Employees," *J. Phys. Conf. Ser.*, vol. 1028, no. 1, p. 12052, Jun. 2018.

[14] Y. Rossanty, D. Hasibuan, J. Napitupulu, M. D. T. P. Nasution, and R. Rahim, "Composite performance index as decision support method for multi case problem," *Int. J. Eng. Technol.*, vol. 7, no. 2.9, pp. 33–36, 2018.

[15] B. Singaravel, T. Selvaraj, and S. Vinodh, "Multi Objective Optimization of Turning Parameters Using Combined Moora and Entropy Method," vol. 40, no. 1, pp. 101–111, 2015.

[16] S. H. Sahir, R. Rosmawati, and R. Rahim, "Fuzzy model tahani as a decision support system for selection computer tablet," *Int. J. Eng. Technol.*, vol. 7, no. 2.9, pp. 61–65, 2018.

[17] A. Indahingwati, M. Barid, N. Wajdi, D. E. Susilo, N. Kurniasih, and R. Rahim, "Comparison Analysis of TOPSIS and Fuzzy Logic Methods On Fertilizer Selection," *Int. J. Eng. Technol.*, vol. 7, no. 2.3, pp. 109–114, 2018.