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Mini Thesis Supervisor Recommender System Using Simple Additive Weighting Algorithms: A Case Study of Universitas Internasional Batam

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Abstract **–** Currently, the selection if thesis supervisors in Faculty of Computer Science at Universitas Internasional Batam is done based on direct consideration of the supervisor candidate's competence, functional, and education. However, this thesis supervisor selection process is not very effective if the student doesn't know a suitable supervisor for the topic of the thesis they have chosen. Therefore, a decision support system is required to determine the thesis supervisor so that the thesis submitted by student is match with the competence of the thesis supervisor candidate. The primary goal of this research is to create a decision support system application that can assist in determining the thesis supervisor. The Research and Development (R&D) technique was employed in this study, with the Simple Additive Weighting (SAW) decision making approach and the ADDIE model for the development process. Lecturer data was collected by distributing questionnaires. Based on the result of SAW calculations, it was found that alternative 7 (A7) and alternative 4 (A4) were the best alternative. From the result of testing on application, the application was able to provide recommendations for thesis supervisors to users based on the calculation using SAW Method. Future research may try to use or combine other decision-making methods, such as AHP or Apriori.
Keywords **–** *Decision Support System, Lecturer, Thesis, SAW Method*

I. INTRODUCTION

College students are individuals who are pursuing higher education at a college, which includes high schools, academies, and the most common is a university. In addition to being given an academic burden to complete lecture assignments, college students also play an important role in the development of a country [1]. In process of completing the undergraduate education level, college student must work on a final project or mini thesis. Final project or mini thesis is one of the requirements for undergraduate students to graduate with a bachelor's degree by presenting a scientific work which is the result of measuring academic ability from the field of science that they are engaged in, by describing analytically and systematically the result of research carried out in accordance with the direction of the supervisor.

In Indonesia, normally undergraduate programs can be completed in eight semesters or four years and the final project or mini thesis is completed in the last semester of the study period as regulated by each faculty, following university standards [2]. Selection of a supervisor is something that must be done by college students to be able to complete their study period. In the preparation of the mini thesis, the supervisor plays an important role in the process of making a student's thesis. In the selection of supervisors sometimes there are less than optimal decisions where the appointed lecturer doesn't match the student criteria, as a result the resulting thesis is poor of quality or students need takes longer time in the [3]. The selection of a supervisor will greatly affect the length of time a student's graduates. Therefore, the selection of supervisors is very important for college students.

Research of Palopak and Lumbantobing on 2019 developed a decision support system (DSS) by utilizing the simple additive weighting (SAW) method as a process in selecting dorm residents. In this selection process several criteria are used to determine which prospective occupants will be accepted. In this study, the criteria used were parental income, number of dependents of parents, number of siblings, willingness to take 17 credits, self-cooking, student debt, and electricity tariffs. The result of this research is web-based application that applies SAW algorithm in the selection of university student dormitory residents [4].

The research of Janti on 2020 conducted an analysis for the selection of shipping expedition services using the Simple Additive Weighting (SAW) Method. The criteria used in this research are price, time weight, and volume. In this study, the result of JNE YES expedition was found as the best alternative based on the time and weight. Meanwhile, based on volume Wahana holds the best alternative [5].

The research of Permatasari and Adhi on 2020 discusses the development of a decision support system to determine the tendency of a student to take courses within the scope of informatics and computer engineering using the Apriori algorithm. The research method used in this study was Research and Development (R&D). the research stage is carried out to collect data in the form of patterns of relationships that occur between students and elective courses. While at the development stage, web-based application development is carried out using the PHP Programming language. The result of this research was a web-based decision support system that is used to generate association rules that can be used as consideration in opening elective courses [6].

Based on the literature review and the background above, to help overcome the above problems, a decision support system is needed. This study focuses in

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developing a decision support system using simple additive weighting algorithm to help college student in the process of supervisor selection.

II. RESEARCH METHODOLOGY

A. Decision Support System

A Decision Support System (DSS) is typically designed to aid in the resolution of a problem or an opportunity. The decision support system (DSS) application is used for decision making. A Computer Based Information System (CBIS) is used in a decision support system application to support solutions to particular unstructured management problems [7]. A decision support system is a system that may make suggestions for decisions based on a range of criteria provided by the decision-making systems approach method, including AHP, SAW, ARAS, and others. In the business world, DSS are frequently used in decision-making processes [8].

B. Simple Additive Weighting (SAW)

The Simple Additive Weighting (SAW) approach is also known as the weighted summing method. Finding the weighted sum of performance ratings for each alternative across all criteria is the main goal of the SAW approach. The SAW technique requires that the choice matrix (X) to be normalized to a scale that is equivalent to all of the alternative ratings that are provided [9], [10]. SAW Method required normalization process before ranking process. While in the normalization process, there are two types of criteria which is benefit and cost [11].

In general, the stages for applying the AHP technique to a problem are as follows [12], [13]:

a. Determine or chose the alternative, namely Ai
b. Identifying the criteria that will be used in decision making, namely Ci.
c. Preparing the decision matrix using criteria (Ci)
d. Normalizing the matrix using the equation adjusted with the type of attribute (benefit or cost) to create the normalized matrix R.

$$R_{ij} = \begin{cases} \frac{X_{ij}}{Max\ X_{ij}} & \text{if } j \text{ atribut is benefit} \\ \frac{Min\ X_{ij}}{X_{ij}} & \text{if } j \text{ atribut is cost} \end{cases} \quad (1)$$

Information:
R_{ij} : Normalization result value.
X_{ij} : attribute value for each criterion.
$Max\ X_{ij}$: the highest value for each of the criteria.
$Min\ X_{ij}$: the lowest value for each of the criteria.

e. The sum of the matrix multiplication normalized R with the weight vector to achieve the highest value picked as the best option (Ai) as a solution is the result of the ranking procedure.

$$V_i = \sum_{j-1}^{n} W_j R_{ij} \quad (2)$$

Information:
V_i : result of each alternative's ranking
W_j : weighted value for each criterion
R_{ij} : Normalization result
The largest value of V_i identifies as the best alternative (Ai)

C. Research and Development Stage

To aid in the development of this research, a defined structure for the steps is required. This framework represents the steps that will be done to solve the difficulties that will be described. This research is divided into 2 stages which is research stage and development stage. Figure 1 is the flow of research stage:

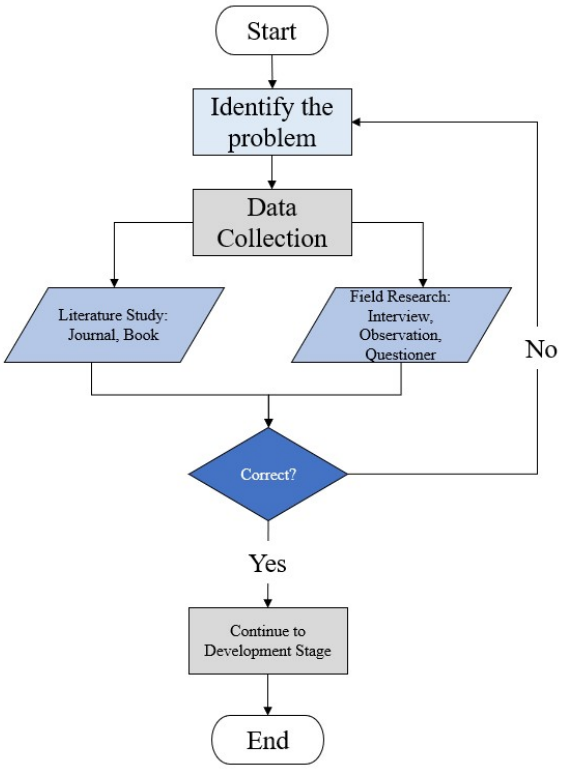

Figure 1 Research Stage

a. Identification the problem that occurred at Universitas Internasional Batam, right now the student selected the thesis supervisor only by personal wishes without considering the supervisor main skill or others information.
b. Data for this study were gathered through interviews, observations, questioners, and a review of the literature. It is done at this stage to collect all the information that will be used to support this research. Observations were conducted directly at Universitas Internasional Batam by looking at how college students choose their thesis supervisor. The interview was performed by directly asking college students how they chose their supervisor. Questionnaires are used to gather data on lecturers. The literature study includes reading a variety of sources of information connected to the research title.. Researchers used online journals and books as reference sources.

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Meanwhile the application development stage will use ADDIE Framework. The ADDIE model is a popular instructional design framework among application designers and developers. It is used by instructional designers in the development and training processes [14]. ADDIE framework consists of 5 steps as shown in the figure 2.

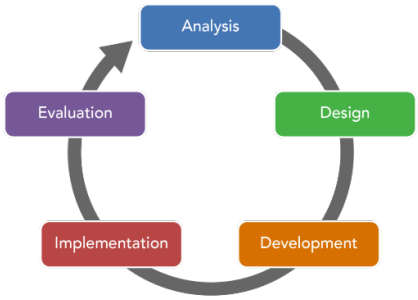

Figure 2 ADDIE Framework

a. The analysis is the preliminary stage that serves as the foundation for further development [15].
b. The ADDIE web-based decision support application's design phase can be described as an overview of creating a unique system design that functions as a single, cohesive unit. Stages to design a system in general can be done after completing the needs analysis stage [16].
c. Development stage is the process of realizing the design steps in real form. At this stage, the SAW algorithm will be implemented in a web-based application.
d. Implementation stage is the stage to do testing to the application developed in the development stage.
e. Evaluation stage is the stage to determine the success of the application that has been made.

III. Results And Discussion

A. Determining of the criteria

This research using Simple Additive Weighting (SAW) which important to determine the criteria and weight for every criterion in process of supervisor selection [17]. In determining thesis supervisor, criteria are needed which later each alternative will be compared based on these criteria. From the result of consultations with thesis supervisor, the following table 1 are the criteria used to determine the thesis supervisor.

Table 1 Criteria and Sub Criteria

Criteria	Sub Criteria
Education	S2
	S3
Functional	Instructor
	Expert Assistant
	Lecturer
	Head Lecturer
	Professor
Competence	Web Design (Level 1)
	Machine Learning (Level 2)
	Digital Marketing (Level 3)
	Design (Level 4)
	Strategic Information System (Level 5)
Lecture Status	Permanent
	Part Time
Number of mentoring students	0-5
	6-10
	11-15
	16-20
	21-25

B. Weight for every criterion and sub criteria

. The weighting for criteria and sub criteria was determined subjectively. Below is the result of weighting:

Table 2 Weight Score

Category	Value
Very Low	0.1
Low	0.25
Medium	0.5
High	0.75
Very High	1

Table 3 Criteria and Weight

Criteria Code	Criteria	Type	Weight
C1	Education	Benefit	25%
C2	Position	Benefit	15%
C3	Competence	Benefit	35%
C4	Lecture Status	Benefit	15%
C5	Number of mentoring students	Cost	10%

Table 4 Sub Criteria Weight

Criteria	Sub Criteria	Weight
Education	S2	0.50
	S3	1.00
Functional	Instructor	0.10
	Expert Assistant	0.25
	Lecturer	0.50
	Head Lecturer	0.75
	Professor	1.00
Competence	Level 1	1.00
	Level 2	0.75
	Level 3	0.50
	Level 4	0.25
	Level 5	0.10
Lecture Status	Permanent	1.00
	Part Time	0.50
Number of mentoring students	0-5	0.10
	6-10	0.25
	11-15	0.50
	16-20	0.75
	>20	1.00

C. Supervisor Candidate Data

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The data of supervisor candidate was collected from questioner. Table 5 is the sample data of the supervisor.

Table 5 Supervisor Candidate Data

Alternative (Ai)	Education	Functional	Competence	Status	Number of Mentoring Students
A1	S2	Lecturer	Digital Marketing	Permanent	>20
A2	S2	Lecturer	Cyber Security	Part Time	16-20
A3	S2	Lecturer	Design	Permanent	11-15
A4	S2	Lecturer	Machine Learning	Permanent	6-10
A5	S2	Lecturer	Machine Learning	Part Time	>20
A6	S3	Head Lecturer	Strategic Information System	Permanent	0-5
A7	S2	Lecturer	Machine Learning	Permanent	6-10

D. Simple Additive Weighting Implementation

Table 6 is the initial matrix of the data

Table 6 Supervisor Candidates Categorical Data

0.50	0.50	0.50	1.00	1.00
0.50	0.50	0.10	0.50	0.75
0.50	0.50	0.25	1.00	0.25
0.50	0.50	0.75	1.00	0.25
0.50	0.50	0.75	0.50	1.00
1.00	0.75	0.10	1.00	0.10
0.50	0.50	0.75	1.00	0.25

Based on table 6 we will do normalization for that data. The normalization will be calculated based on the type of the criteria. For the benefit criteria will use the largest value. There are three criteria that are classified as benefits which is C1 with largest value 1, C3 with largest value 1, and C4 with largest value 1. And for cost criteria will use the smallest value. There are two criteria that are classified as cost which is C2 with smallest value 0.5 and C5 with largest value 0.

After calculated the largest or smallest value for each criterion, that number will used to calculate the final number using Simple Additive Weighting (SAW) formula. Based on the result of the normalization of initial matrix, it produces an R Matrix. Table 7 is the result of normalized R Matrix.

Table 7 R Matrix

0.50	0.67	0.67	1.00	0.10
0.50	0.67	0.13	0.50	0.13
0.50	0.67	0.33	1.00	0.40
0.50	0.67	1.00	1.00	0.40
0.50	0.67	1.00	0.50	0.10
1.00	1.00	0.13	1.00	1.00
0.50	0.67	1.00	1.00	0.40

After calculated R Matrix, then the ranking is calculated using equation 2. The criteria weight (W) for the calculation will based on table 3, W = [25; 15, 35; 5; 20].

$$V_{A1} = (25)(0.50) + (15)(0.67) + (35)(0.67) + (15)(1) + (10)(0.1) = 62$$

$$V_{A2} = (25)(0.50) + (15)(0.67) + (35)(0.13) + (15)(0.50) + (10$$

$$V_{A3} = (25)(0.50) + (15)(0.67) + (35)(0.33) + (15)(1) + (10)($$

$$V_{A4} = (25)(0.50) + (15)(0.67) + (35)(1) + (15)(1) + (10)(0.4)$$

$$V_{A5} = (25)(0.50) + (15)(0.67) + (35)(1) + (15)(0.5) + (10)(0.$$

$$V_{A6} = (25)(1) + (15)(1) + (35)(0.13) + (15)(1) + (10)(1) =$$

$$V_{A7} = (25)(0.50) + (15)(0.67) + (35)(1) + (15)(1) + (10)(0.4)$$

Based on the results of the above calculations, it produces the best alternative thesis supervisor. Best alternative based on the calculation are alternative 4 and alternative 7 and alternative 4 with score 76.55. The following table 8 is the ranking results.

Table 8 Ranking Results

Alternative (Ai)	Result	Ranking
A7	76.55	1
A4	76.55	1
A6	69.55	3
A5	66.05	4
A1	62.00	5
A3	53.10	6
A2	35.90	7

E. System Implementation

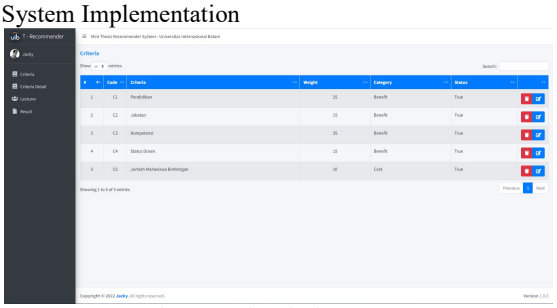

Figure 3 Main Criteria Page

Main criteria page as shown in figure 3 used to view existing criteria. At this page user can also change the weight or the type of each criterion.

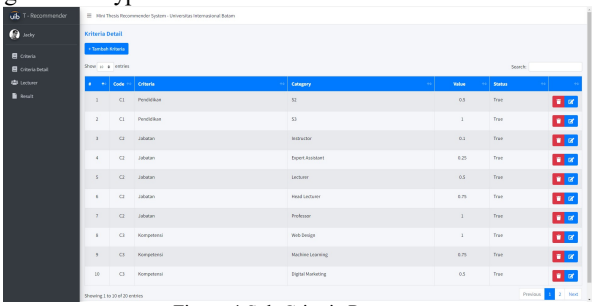

Figure 4 Sub Criteria Page

Sub criteria page as shown in figure 4 used to view existing sub criteria. At this page user can add new sub criteria, update and delete it.

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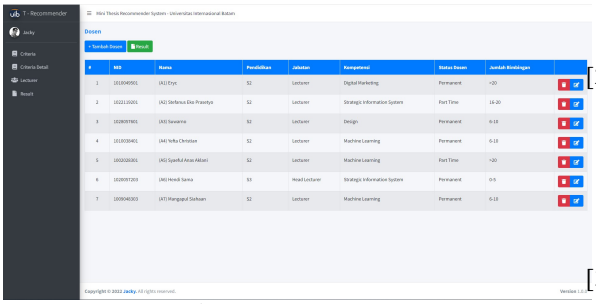

Figure 5 Lecturer Page

Lecturer page as shown in figure 5 used to view all existing lecturer information.

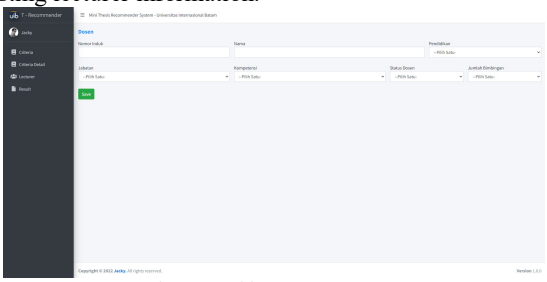

Figure 6 Add New Lecturer Page

In add new lecturer page as shown in figure 6, users can add new lecturer information. Users need to fill all required field in this page before saving the data.

Figure 7 Result Page

Result page as shown in figure 7 will be showing all the calculations result such as alternative matrix and final ranking data. Based on the test result on the web-based application system, each of the top alternatives that have the highest value can be used as the consideration in the selection of mini thesis supervisor.

IV. CONCLUSION

This study using Simple Additive Weighting algorithm to help in the selection of mini thesis supervisor. By developing decision support system application for mini thesis supervisor selection, it will facilitate and speed up appropriately choosing a mini thesis supervision. The ranking results using SAW method are by sorting the largest numbers to the smallest. The result of the ranking with SAW method, the best alternative is alternative 7 (A7) and alternative 4 (A5) with the same score of 76.55. For further research may try to use another algorithm like AHP or Apriori.

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