Decision Support System for Determining Graduate Profiles for Students Using the Simple Additive Weighting Method

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Abstract. The graduate profile is a role that can be performed by graduates in the field of expertise or work fields after completing study in the study program. The graduate profile is also a very important component that becomes the identity of a study program so that a study program with the same name can be distinguished from the specified graduate profile. This study uses a Decision Support System (DSS) which will be obtained using the Simple Additive Weighting (SAW) method for drawing conclusions from the data that has been analyzed. The study used five stages, namely problem analysis, literature review, data collection, criteria determination, criteria and alternatives weighting, SAW method implementation, and the last stage of drawing conclusions. The result is that the graduate profile will be more effective if using DSS calculation analysis and drawing conclusions using the SAW method. This can be seen from the results of the analysis of one student who obtained a high match value on the criteria A1 (Intelligent System Developer).

Keywords: Graduate Profile, Decision Support System (DSS), Simple Additive Weighting (SAW).

1 Introduction

The graduate profile is a role that can be performed by graduates in the field of expertise or work fields after completing study in the study program. The graduate profile is also a very important component that becomes the identity of a study program so that a study program with the same name can be distinguished from the specified graduate profile. Furthermore, the graduate profile is used as a guide to determine graduate learning outcomes, subject learning outcomes and become a guide for determining courses. However, it is different from reality, when students conduct lectures until they are about to graduate. The graduate profile never existed, because it is no longer discussed and like not important. This is due to many factors but that is not the purpose of this research. The aims of this research is to facilitate study

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programs and students to find out the profile of graduates they have achieved by utilizing data on the value of courses that have been completed by students. So, database of graduate profiles can be a guide for students to make appropriate plans to continue their studies and find work. Then for study programs the graduate profile database is useful for evaluating the profile of the graduate and for comparison with tracer study data related to the suitability of the work place with the graduate profile.

Research related to determining the profile of graduates is very important because the output of the application is the availability of a graduate profile database that includes student identities and graduate profiles and is accompanied by other supporting descriptions. Because this research, the graduate profile which is actually very important in carrying out learning activities will be more effective and not just a formality.

This research will apply the Simple Additive Weighting (SAW) method to determine a suitable graduate profile for students. The SAW method is one of the simplest and most widely used Multi Attribute Decision Making (MADM) problem solving methods [1]. The SAW method is a method in a basic concept that can make a decision on the total weight of each alternative on all attributes [2], [3].

2 Research Method

The stages in this research as shown in Figure 1.

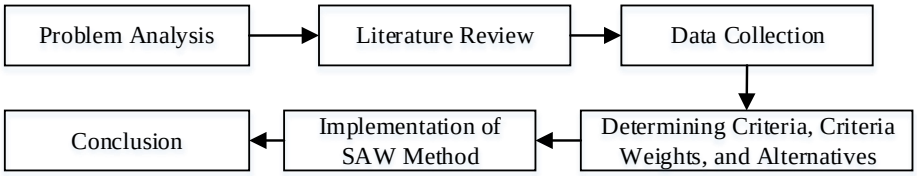

Fig.1. Research Stages.

2.1 Problem Analysis

Problem analysis phase is for identify the object of research and the related environment in order to explore the situation and conditions of the problems that happened. Problem analysis was conducted to collect information about the process of formulating graduate profiles, curriculum documents, and implementing graduate profiles. In addition, this phase also analyzes the role of students and study programs in determining the profile of graduates.

2.2 Literature Review

Literature review is a technique of integrating findings and perspectives from many empirical findings where this technique can answer research questions with strengths that no single study has [4]. In general, literature reviews summarize and evaluate a collection of writings on a particular topic [5]. Based on this, the literature review in this study is a written summary of the results of the study of journals, books, and other documents in accordance with the needs of developing a profile of study program graduates. This phase is search for existing graduate

profiles. Graduate profiles should be used as a guide to determine graduate learning outcomes, subject learning outcomes, then they become a guide for determining courses. However, it is different from what happened in the field, when students conduct lectures until they are about to graduate, like the graduate profile never existed, because it is no longer discussed, and even seems unimportant.

2.3 Data Collection

This phase is collecting data on graduate profiles and final semester student grades. Graduate profile data is obtained from academic books (curriculum documents) of the Computer Science Study Program. Meanwhile, student score data was obtained from the Student Study Results Sheet (LHS) using a questionnaire.

2.4 Determining Criteria, Criteria Weights, and Alternatives

Determination of criteria, criteria weights, and alternatives refers to academic books (curriculum documents). The criteria in this study are the subjects, and the alternative is the graduate profile. Meanwhile, the determination of the weight of each criteria is set dynamically based on course mapping or course linkages that support each graduate profile. Courses that support the achievement of a graduate profile will gain significant weight compared to courses that do not directly support it.

2.5 Implementation of Simple Additive Weighting

Decision Support System (DSS) is a computer-based system designed to increase effectiveness in decision making that can solve semi-structured and unstructured problems, so that the decision-making process can be of higher quality [6]. DSS will be effective if it has five characteristics, namely, performance, ease of use, trustworthiness, cost, and conformity to existing habits or relevance [7]. One method that can be used in DSS is Simple Additive Weighting (SAW).

Simple Additive Weighting (SAW) is a method in a basic concept that can make a decision on the total weight of each alternative on all attributes [2], [3], [8]. The SAW method requires a process of normalizing the decision matrix x to a scale that can be compared with existing alternative ratings [9]. The formula for the SAW method is as follows [2]:

$$r_{ij} = \begin{cases} \frac{X_{ij}}{Max\ x_{ij}} If\ j\ is\ the\ benefit\ attribute \\ \frac{Min\ X_{ij}}{X_{ij}}\ If\ j\ is\ the\ cost\ attribute \end{cases} \quad (1)$$

Note :
r_{ij} = normalized performance branch value
X_{ij} = attribute value that is owned from criterion
$Max\ x_{ij}$ = the highest value of each criteria
$Min\ X_{ij}$ = the lowest value of each criteria

Meanwhile, the level of preference for each alternative (Vi) is as follows:

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

Note :
V_i = end value alternative
W_j = weight predetermined
r_{ij} = normalization matrix

There are several stages of SAW in this research, namely as follows [9], [10]:

1. Determine the criteria that will be used as a reference in the decision, namely Ci
2. Determine the suitability rating of each alternative on each attribute
3. Make a decision based on the criteria matrix (Ci), then the matrix is normalized based on the equation that is adjusted to the type of attribute, so as to obtain a normal matrix
4. The final result obtained from the matrix multiplication ranking process is the addition of normalized R with a weight vector so that the largest value is chosen as the best alternative (Ai) as a solution.

2.6 Conclusion

Conclusion or drawing conclusions is the final stage in this research. Based on the Big Indonesian Dictionary, a conclusion is a decision obtained based on a deductive or inductive way of thinking from a particular discussion or idea. After obtaining the final results at the implementation stage, at this stage the final conclusion is obtained regarding the graduation profile of the study program.

3 Result and Analysis

There are several steps to calculate the profile of student graduates using the Simple Additive Weighting (SAW) method, including:

1. Alternative Data
   Alternative data is graduate profile data obtained from the curriculum document of the Computer Science Study Program. Alternative data in this study shown in Table 1.

Table 1. Alternative Data (Graduate Profile)

Alternative	Information
A1	Intelegent System Developer
A2	Software Engineering
A3	Analyst System

2. Criteria and Weights
   The criteria in this study are courses starting from semester 5 to semester 7. The selection of semesters is based on the availability of competency courses for each graduate profile. The criteria in this study are courses as shown in Table 2.

Tabel 2. Greating Profiles Criteria

Criteria	Information	Criteria	Information
C1	Data Communication and Computer Network	C12	Cryptography and Information Security
C2	Numerical Method	C13	Decision Support System
C3	Software engineering	C14	Pattern recognition
C4	Multimedia	C15	Computational Science
C5	Artificial Intelligence	C16	Bioinformatics
C6	Mobile Computing	C17	Fuzzy Logic (Specialization)
C7	Digital Image Processing	C18	Genetic Algorithm (Speciality)
C8	Big Data and Mining Data	C19	Computational Physics (Specialization)
C9	Numerical Analysis	C20	Research methodology
C10	Entrepreneurship and professional ethics	C21	IT Project Management
C11	Modeling and Simulation		

Then determine the weight value for each criterion that is used as a reference in decision making. The weight of the criteria in this study can be seen in Table 3 [11].

Tabel 3. Criteria Weight

Weight	Score
Significant coverage	9
Some coverage	5
Not required	1

3. Value of the weight of each alternative for each criterion
   The next step is to determine the weight value of each alternative for each criterion. The weight value of each alternative for each criterion used in determining the profile of student graduates can be seen in Table 4.

Table 4. The value of the weight of each alternative for each criterion

Profile	Criteria																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
A1	5	9	9	5	9	9	9	9	9	5	9	1	9	9	9	9	9	9	9	1	5
A2	9	5	9	9	5	9	5	5	5	9	1	9	9	1	1	1	5	1	1	5	9
A3	9	9	9	1	5	5	1	5	9	9	5	9	1	1	1	1	9	1	1	9	9

The next step is to normalize the weight value of each alternative for each criterion. All criteria used are benefits. The formula for normalizing the weight value can be seen in Equation 3 [2], [12].

$$r_{ij} = \frac{X_{ij}}{Max\ x_{ij}} If\ j\ is\ the\ benefit\ attribute \quad (3)$$

Note:
r_{ij} = normalized performance branch value

X_{ij} = attribute value that is owned from criterion
$Max\ x_{ij}$ = the highest value of each criteria
$Min\ X_{ij}$ = the lowest value of each criteria

The results of normalizing the weight value of each alternative for each criterion can be seen in Table 5.

Table 5. Results of Normalization of Weight Values for each Alternative for Each Criterion

Profile	Criteria																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
A1	0.6	1	1	0.6	1	1	1	1	1	0.6	1	0.1	1	1	1	1	1	1	1	0.1	0.6
A2	1	0.6	1	1	0.6	1	0.6	0.6	0.6	1	0.1	1	1	0.1	0.1	0.1	0.6	0.1	0.1	0.6	1
A3	1	1	1	0.1	0.6	0.6	0.1	0.6	1	1	0.6	1	0.1	0.1	0.1	0.1	1	0.1	0.1	1	1

4. Student Value Calculation
   The next step is to make calculations based on student scores. Student scores are obtained from the Study Results Sheet (LHS). For example, the calculation is carried out for Student X. Meanwhile, the results of the conversion of student scores are based on the assessment guidelines that apply on campus. The value of Student X and the results of the conversion of Student X's scores can be seen in Table 6.

Table 6. Values and Conversion Results of Student X Values

Initial	Criteria																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
X	A	A	A	A	A	A	A	A	B	A	B	B	B	B	A	A	A	A	A	B	A
	4	4	4	4	4	4	4	4	3	4	3	3	3	3	4	4	4	4	4	3	4

The next step is to normalize student scores using the Min-Max Formula [13]. The formula for normalization can be seen in Equation 4.

$$N = \frac{X - MinValue}{MaxValue - MinValue} \quad (4)$$

Note:
N = Min-Max Normalization
MaxValue = The largest value in the attribute being compared
MinValue = The smallest value in the attribute being compared

The results of normalizing the value of Student X can be seen in Table 7.

Table 7. Results of Normalization of Student Values X

Initial	Criteria																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
X	1	1	1	1	1	1	1	1	0.7	1	0.7	0.7	0.7	0.7	1	1	1	1	1	0.7	1

5. Calculation of Final Value (Preference Value)
   The next step is to calculate the final result or preference value obtained from the sum of the results of multiplying the normalization of student scores and the normalization of the alternative weight values for each criterion. Calculation of the final results shown in Table 8.

Table 8. Final Calculation Results

Profile	Result
A1	16.037037
A2	11.444444
A3	10.851852

Based on the calculation results and ranking results in Table 8, the profile of A1 graduates has the highest score compared to the profiles of A2 and A3 graduates. This indicates that Student X is a good fit for the A1 (Intelligent System Developer) graduate profile.

4 Conclusion

Based on the final calculation results in each category by one student, it shows that the student is suitable for the A1 graduate profile or on the criteria for developing intelligent systems. Therefore, decision support system for determine the graduate profile is an important system and can help students in a more effective learning process until these students graduate with maximum results and can be used as evaluation material or comparison with tracer study data related to the suitability of the workplace with the graduate profile.

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