

Decision Support System to Majoring High School Student Using Simple Additive Weighting Method

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ABSTRACT : *Decision choice problems occur in every age levels, including teen-age when students will go to higher school level education. Senior High School is the first level of education that student chooses and follows the majoring class of their interest. But students usually simply select the major not based on a careful consideration or reckoning. Therefore, Decision Support System that can help students in choosing majors is needed. The system will be developed as a web-based application program, using Simple Additive Weighting (SAW) method better known as the weighted sum method. This SAW method is used to generate the recommendation majoring result that will be given to students in a recommendation list majors, which sorted based on highest to lowest percentage result. This result can be a referable for students in choosing the majors.*

Keywords - *Decision Support System, Majors, SAW Method*

I. INTRODUCTION

In human life, there are always a few decisions choice that would be very important for our future. Many things could affect any decision taken by every human being. But then, the decision taken by someone are commonly not based on a careful consideration or reckoning until some possibility problems never previously thought appear in the future. Decision choice problems occur in every age levels, including teen-age when students will go to higher school level education.

Senior High School is the first level of education that student chooses and follows the majoring class of their interest. But in fact, there are still a lot of students out there does not suited with major chosen. Many factors make causes of the occurrence of these problems. They simply follow the advice and encouragement from their parents, or follow the major chosen by their close friend. In addition there is a paradigm in the school environment who stated that one major better than others, so many students selected the major because of it.

Whereas, this decision choice is actually more dependent on interest and potential academic

existing in students itself. Not mentioned dependent on environmental factors that will only affect their decision choice, which will at last cause aversion learning and decline of academic achievement, the students feel not suited with their chosen major.

Currently, Indonesian Government is implementing a new education system, called “Kurikulum 2013”, which sets a high school student must follow the majoring classroom (in Indonesian called “peminatan”) in 10th grade [1]. Students have to set their majoring choice when their graduated from the junior high school. But how can students determine which groups of majors, while a learning experience in classroom has never been done by any new student. If students choose majors based on factors that previously mentioned, there will be the possibility of a problem among students with majors chosen. Therefore, students have to do a preparation in choosing majors, in order to prevent future problems.

Therefore, Decision Support System that can help students in choosing appropriate major with their academic ability and interest is needed. The system will be developed as a web-based application program, using Simple Additive Weighting (SAW) method to generate the recommendation majoring result. The result will be given in a recommendation list majors, which sorted based on highest to lowest percentage.

II. LITERATURE REVIEW

In this section, theories, basic concept and method used in making this decision support system application for selecting majors will be discussed.

2.1 Decision Support System

Definition Support System concepts firstly disclosed in 1970 by Scott Morton with term “Management Decision System”, means a system based on computerization that can help make a decision used data and models to solve unstructured problems [2].

Decision Support System is an information system based on computerization, to produce certain alternatives decision to help certain side about handle the problems used data and model. Decision Support System only provides the alternative decisions, while the final decision is still determined by decision-maker. Decision Support System integrated personal intellectual resources and computer capability to improve the decision quality [3].

Decision support system commonly built to support the solution of a problem or to evaluate a chance. DSS is intended to support the management in analytical working perform with unstructured situation and unclear criteria [4].

2.2 Multiple Criteria Decision Making

Multiple Criteria Decision Making (MCDM) is a method of decision making to set the best of various alternatives based on certain criteria. Criterion is usually a size, rules or a standard used in decision making. Based on the objective, MCDM can be divided into two models (Zimmermann, 1991): Multi Attribute Decision Making (MADM) and Multi Objective Decision Making (MODM) [5]. MCDM and MADM usually used to describe same class or categories. MADM used to solve the problems about discrete space. Therefore, MODM used to solve the problems of continuous space. There are some common features used in MCDM (Janko, 2005), they are [5]:

1. Alternative
2. Criteria
3. Conflict between the criterias
4. Decision weight
5. Decision matrix

2.3 Fuzzy Multi-Attribute Decision Making

If the data or information provided by decision maker nor the data about attributes of alternatives can not be fully provided, contain uncertainty or inconsistency, so Fuzzy Multi-Attribute Decision Making (FMADM) method can be user to solve this problems. The inaccuracy and uncertainty problems can be caused by a few things [5], like:

1. The information can not be calculated.
2. The incomplete information.
3. The unclear information.
4. Partial waiver.

One of the mechanisms to resolve problem of fuzzy MADM is to apply MADM methods, like Simple Additive Weighting (SAW), Weighted Product (WP), or Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), to perform ranking, previously the conversion of fuzzy data to crisp data performed. If the fuzzy data

given in linguistic form, then the data must be converted to fuzzy numbers first, then converted again into crisp numbers.

2.4 Fuzzy Number

One of the interesting features of fuzzy logic is that fuzzy logic can model the information contained obscurity through the concept of fuzzy numbers, and using ordinary arithmetic operations (Lootsma, 1997) [5]. Fuzzy numbers do more qualitative processing operation than quantitative processing operation. Therefore fuzzy number is usually expressed linguistically. Preferences format of fuzzy number in linguistic form was standardized and presented in Table 1 (Cheng, 1999) [5]:

Table 1: Preference Table

Fuzzy Number	Preference
Very Good	(1; 0.8; 1)
Good	(0.75; 0.6; 0.9)
Fair	(0.5; 0.3; 0.7)
Poor	(0.25; 0.05; 0.45)
Very Poor	(0; 0; 0.2)

2.5 Simple Additive Weighting

SAW method is often be known as term weighted summation method. Basic concept of SAW method is seeking a weighted summation of the performance rating form each alternative on all attributes (Fishburn, 1967) (Mac-Crimmon, 1968) [4]. SAW method needs a normalization process of the decision matrix (X) to a scale which can be compared with all alternatives rating. This method has the formula as shown below.

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\max_i x_{ij}}, & \text{if } j = \text{benefit} & (2.1) \\ \frac{\min_i x_{ij}}{x_{ij}}, & \text{if } j = \text{cost} & (2.2) \end{cases}$$

Where r_{ij} is a normalized performance rating of alternative A_i ($i = 1, 2, \dots, m$) and attribute C_j ($j = 1, 2, \dots, n$). Preference value for each alternative (V_i) is given as:

$$V_i = \sum_{j=1}^n w_j r_{ij} \quad (2.3)$$

Where w_j is a preference weight of each given criteria. Value of V_i which bigger indicates that alternative A_i is chosen.

III. APPLICATION SYSTEM DESIGN

This section is describes about detail process of developing decision support system design for majoring choice, which includes system design, determines the preference format of fuzzy number, application dan interface design.

3.1 System Design

As explained earlier, the SAW method can solve the problems with multi-criteria, which means that problems in the majoring choice, can be solved by this method as well. This decision support system uses a number of criteria comes from user data input. Then values of each criterion are used to obtain the best alternatives.

Alternative majors recommendations provided in the system are Math and Natural Science (A1), Social Science (A2) and Language and Cultural Science (A3). While the criteria used to generate the best alternative in the decision support system consists of:

1. Average report book value (C1).
2. Average national exam value (C2).
3. Priority majors (C3).
4. Non academic achievement (C4).
5. Simulation Test result (C5).

Fig. 1 is a simple overview of the process that will occur in the decision support system for majoring choice.

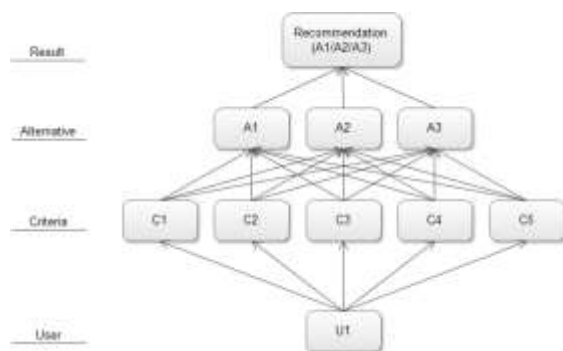


Figure 1. Process Overview

3.2 Preference Format

The criteria used in the decision support system has not definite calculation units, so make the values obtained can not be calculated with the same unit scale calculations. It required format preferences for every existing criteria, including a preference for criteria weights used in the process of generating alternative recommendation majors. Preference format on this decision support system are as follows:

1. Criteria weight is divided into 5 fuzzy numbers, they are Very Low (VL), Low (L), Sufficient (S), High (H) and Very High (VH). This fuzzy numbers will be converted into a crisp number, which will be more clearly presented in Table 2.

Table 2: Criteria Weight

Fuzzy Number	Value
Very Low	0
Low	0.25
Sufficient	0.5
High	0.75
Very High	1

2. Average report book value, is divided into 5 fuzzy numbers, they are Very Low (VL), Low (L), Sufficient (S), High (H) and Very High (VH). This fuzzy numbers will be converted into crisp numbers with a range of values that presented in Table 3.

Table 3: Average Report Book Value

Range Value	Fuzzy Number	Value
Value <= 50	Very Low	0
51 <= Value <= 65	Low	0.25
66 <= Value <= 80	Sufficient	0.5
81 <= Value <= 90	High	0.75
91 <= Value <= 100	Very High	1

3. Average national exam value, is divided into 5 fuzzy number consist of, Very Low (VL), Low (L), Sufficient (S), High (H) and Very High (VH). This fuzzy numbers will be converted into crisp numbers with a range of values as presented in Table 4.

Table 4: Average National Exam Value

Range Value	Fuzzy Number	Value
Value <= 40	Very Low	0
41 <= Value <= 60	Low	0.25
61 <= Value <= 80	Sufficient	0.5
81 <= Value <= 90	High	0.75
91 <= Value <= 100	Very High	1

4. Priority majors, is divided into 3 fuzzy numbers, they are Loe Priority (LP), Priority (P), dan High Priority (HP). This fuzzy number will be converted into crisp number with priority value which more clearly presented in Table 5.

Table 5: Priority Majors

Priority Value	Fuzzy Number	Value
Priority = 3	Low Priority	0.25
Priority = 2	Priority	0.5
Priority = 1	High Priority	0.75

- Non academic achievement, is divided into 2 fuzzy number consist of, None (N) dan Have (H). This fuzzy number will be converted into crisp number with owned value that presented in Table 6.

Table 6: Non Academic Achievement

Owned Value	Fuzzy Number	Value
Owned = 0	Non	0.5
Owned => 1	Have	1

- Simulation test result is divided into 4 fuzzy numbers, they are Low (L), Sufficient (S), High (H), Very High (VH). This fuzzy numbers will be converted into crisp numbers with a range of right values that presented in Table 7. The number of questions that will be given on the simulation of the test is 20 questions for each alternative.

Table 7: Simulation Test Result

Range Value	Fuzzy Number	Value
Right <= 30%	Rendah	0.25
31% <= Right <= 50%	Cukup	0.5
51% <= Right <= 70%	Tinggi	0.75
71% <= Right <= 100%	Sangat Tinggi	1

Table 8, Table 9 and Table 10 are examples of a settlement to provide the best alternative in the selection of majors by using the SAW method.

Table 8: User A

No.	Alternative	C1	C2	C3	C4	C5
1.	A1 (Math Natural Science)	73	88	1	0	18
2.	A2 (Social Science)	85	92	2	1	16
3.	A3 (Language Culture Science)	70	80	3	0	16

After that, each value in table 8, for example, is converted into decision matrix X using crisp numbers predetermined. Decision matrix X is presented in Table 9.

Table 9: Decision Matrix X for User A

No.	Alternative	C1	C2	C3	C4	C5
1.	A1	0.5	0.75	0.75	0.5	1
2.	A2	0.75	1	0.5	1	1

3.	A3	0.5	0.5	0.25	0.5	1
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Then decision maker, in this system is administrator, will be determined the weight for each criteria. The weight used is as defined in Table 2. For example, Weight given by decision makers to C1, C2 and C4 are 0.5, while weight given to C3 is 0.75, and to C5 is 1. For more details, each criterion weight is presented in equation (3.1).

$$W: [0.5; 0.5; 0.75; 0.5; 1] \quad (3.1)$$

After that, each value in Table 9 will be converted according to equation (3.2) as follows.

$$r_{ij} = \frac{X_{ij}}{\text{Max}_{ij} X_{ij}} \quad (3.2)$$

Where r_{ij} is a normalized performance rating of alternative A_i ($i = 1, 2, \dots, m$) and attribute C_j ($j = 1, 2, \dots, n$).

Afterward, Table 9 will be normalized and decision matrix R will be obtained. Decision matrix R is shown in Table 10.

Table 10: Decision Matrix R for User A

No.	Alternative	C1	C2	C3	C4	C5
1.	A1	0.667	0.75	1	0.5	1
2.	A2	1	1	0.667	1	1
3.	A3	0.667	0.5	0.333	0.5	1

Then, the ranking process for each element matrix R in the Table 10 can be done by using equation (3.3) as follows.

$$V_i = \sum_{j=1}^n w_j r_{ij} \quad (3.3)$$

Where w_j is a preference weight of each given criteria. The greater V_i value indicates that alternative A_i is elected.

Manual calculation to obtain the best alternative of each element in decision matrix R is presented below.

$$\begin{aligned} V_1 &= (0.667)(0.5) + (0.75)(0.5) + (1)(0.75) + \\ &\quad (0.5)(0.5) + (1)(1) \\ &= 0.333 + 0.375 + 0.75 + 0.25 + 1 \\ &= 2.708 \end{aligned}$$

$$\begin{aligned}
 V_2 &= (1)(0.5) + (1)(0.5) + (0.667)(0.75) + \\
 &\quad (1)(0.5) + (1)(1) \\
 &= 0.5 + 0.5 + 0.5 + 0.5 + 1 \\
 &= 3.000
 \end{aligned}$$

$$\begin{aligned}
 V_3 &= (0.667)(0.5) + (0.5)(0.5) + (0.333)(0.75) \\
 &\quad + (0.5)(0.5) + (1)(1) \\
 &= 0.333 + 0.25 + 0.25 + 0.25 + 1 \\
 &= 2.083
 \end{aligned}$$

In this manual calculation, the largest value obtained is in V_2 with the outcomes 3.000. Therefore A_2 is the best alternative for User A.

3.3 Application Design

The application design made aims to describe the process occurs in the system visually. Application design can be described with one of UML diagrams, that is use case diagrams.

Use case diagrams are functional diagrams illustrate basic function of system. It shows what users can do and how the system should respond to the user's actions. Use cases are the primary drivers for all the UML diagramming techniques. A use case communicates at a high level what system needs to do, and all the UML diagramming techniques were build based on use-case functionality in a different way for a different purpose [6]. Application design made in a use case diagram is presented in Fig. 2 below.



Figure 2. Use Case Diagram

On the application system, users can try a simulation for selecting a major. Users will get the result that can be used as a reference in actual selecting majors in school. In this system, information related to the majors and guidance for users in using the application also has provided.

3.4 Interface Design

Interface design is the process of defining how a system will interact with external entities, the user. This section will explain about the layout design used in the application. Pages included in layout design of this section are:

1. Home page layout is the first display page when the application starts. The user can see some images, packed in the image slider on the home page related with the majoring choice. There are five buttons can be accessed by user, which is available in menu bar. Text 1 and Text 2 on the home page layout will contain information about developers and appear on every page layout on application. Home page layout is shown in Fig. 3.



Figure 3. Home Page Layout

2. Simulation page is a page accessed after user logged in. Menu bar turned into six menus as simulation page accessed and the login menu change into logout. This page is the start page for users who will try the simulation. Simulation page layout is shown in Fig 4.



Figure 4. Simulation Page Layout

3. Report book page input form layout, is a page displayed after the simulation page. In this form the user must input their junior high school report book values from the 1st semester to 6th semester. The value entered is the values of the math, bahasa, science, social and English subjects. Report book page input form layout is shown in Fig. 5.



Figure 5. Report Book Page Input Form Layout

4. National exam page input form layout is a page displayed after users input their report book values on form input report book page. This input form actually not only consist of the form for input the national exam values, but also including the form for selecting the priority major and an input non-academic achievement owned by user. On this page the user must enter their junior national exam, choose a priority majors which they prefer and

fill out non-academic achievements form if they have. If the user does not have non-academic achievements, this form can be ignored. National exam page input form layout is shown in Fig. 6.



Figure 6. National Exam Page Input Form Layout

5. Simulation test page layout, is a page uses for advising the majoring simulation placement test. User will be given 10 questions for each subject. Subjects used in this simulation test consist of math, bahasa, science, social and English subjects. Simulation test page layout is shown in Fig. 7.



Figure 7. Simulation Test Page Layout

6. Result page layout, is a page provide information about majoring simulation result. This page is displayed to each user who tries the simulation. Results are displayed on this

page, given in the list of recommendations majors as well as a percentage value of simulation done before. Results are also given in form of diagram. It is intended to allow users read the recommendations obtained easily. Result page layout page is shown in Fig. 8.



Figure 8. Result Page Layout

IV. CONCLUSION

System design that has been described can be so helpful if it used to help students prepare in choosing major. Implementation to a programming language will very likely be done in order to the result of implementation can be used as much as possible with the design that have been made. Therefore, the further development is needed in order to this application system can be real implemented.

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