DECISION SUPPORT SYSTEM FOR ACCEPTANCE SCHOLARSHIP WITH SIMPLE ADDITIVE WEIGHTING METHOD

Yogiek Indra Kurniawan

Universitas Muhammadiyah Surakarta
Pabelan, Kartasura, Surakarta, Central Java, Indonesia

yogiek@ums.ac.id

Abstract

A large number of scholarships have been extensively distributed in the educational institutions including college and university. It is, however, vulnerable to subjectivity. In general, students applying for the scholarship will be selected by the committee that may be subjective in the assessment process. In consequence, it can affect the result of scholarship recipients. Decision Support System (DSS) is a computer-based information system that supports the decision activities to be more. One method of the application of decision support systems is Simple Additive Weighting (SAW). This study was exploring the application of SAW in the case study of scholarship recipient selection process by weighting some predetermined criteria.

Keywords: Scholarship, Decision Support System, Simple Additive Weighting, method.

Presenting Author's biography

Yogiek Indra Kurniawan. Lecturer at Informatics Engineering from Communication and Informatics Faculty in Universitas Muhammadiyah Surakarta. Professional trainer that concern to information system development and web based software development. Now, live in Surakarta, Central Java, Indonesia.

I. Introduction

Scholarships are frequently provided for the students of university who fulfill the specified criteria in accordance to the requirements. The number of students who apply for a scholarship would be a problem for management to determine which students are entitled to a scholarship. Several aspects will be used as parameters of including academic and non-academic achievements as well as the inability of students to afford the education fee in that university. However, the process to select the scholarship recipients in university is frequently carried out subjectively by Student Council or committee.

This study was aimed to propose the application of Decision Support System (DSS) to determine the candidates' eligibility in scholarship selection process. Subsequently, the method of Simple Additive weighting method (SAW) was applied to determine the scholarship recipients. This method was

preferred due to its capability in sort out the optimal alternative from many alternatives, in this case the alternative refers to the students who are eligible to receive the scholarship based on certain criteria. This research was commenced by weighting the value of each attribute or criteria and ranking the alternatives. Decision support systems in this case study was made by using web-based programming language PHP with MySQL database. Web-based system was established since it is a flexible system which can be accessed by everyone anywhere and anytime.

II. Decision Support System (DSS)

Decision Support Systems (DSS) is a computer-based system to facilitate the decision making process [1]. It is adaptive, interactive, flexible, and specifically developed to support the solution of unstructured problem to improve the quality of decision making. Hence, DSS can be defined as an adaptive, flexible, interactive computer-based system which is useful to solve unstructured problems and thereby increasing the value of the decisions [1].

III. Simple Additive Weighting (SAW)

Simple Additive Weighting (SAW) method is often also known as term weighted summation method [2]. The basic concept from SAW is to find weighted summation rating performance of each alternative on all attributes. SAW method requires a process of normalizing the decision matrix (X) to a scale which can be compared with all the rating alternatives exist [2].

The steps in SAW are [3]:

a. Determining the criteria that will be used as a reference in the decision, namely Ci.
b. Determining alternative weights on each criterion.
c. Making decisions based on criteria matrix (Ci)
d. Normalizing the matrix based on equations that are tailored to the type of attributes (attributes benefit or attribute costs) in order to obtain the normalized matrix R. The formula for determining the normalized matrix R are as follows :

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\underset{i}{Max}\, x_{ij}} & \text{if j is benefit attribute} \\ \dfrac{\underset{i}{Min}\, x_{ij}}{x_{ij}} & \text{if j is cost attribute} \end{cases} \quad (1)$$

e. Determining Final Value
   To determine final results, use a value that is the value obtained from the ranking process is summation of the normalized R matrix multiplication with the weight vector in order to obtain the greatest value will be selected as the best alternative (Ai) as a solution. Preference value for each alternative (Vi) is given as:

$$\text{Vi} = \sum_{j=1}^{n} \text{w}_j r_{ij} \quad (2)$$

   Vi value larger indicates that Ai is chosen alternative.

IV. Analysis and Discussion

The design of a Decision Support System for acceptance a scholarship by using Simple Additive Weighting (SAW) method will follow steps which has been described in the previous section.

IV.1 Determination of Criteria

Several aspects as the critera in the assessment system are as follows:

C1 = Grade Point Average (GPA)
C2 = Parent's Earnings
C3 = The number of Parent's dependent
C4 = Active In Organizations
C5 = Achievement

Each scholarship can be determined weight or percentage of each criterion based on the type and needs of scholarships. For example, some of scholarships have a tendency to assign a higher weight to criteria cumulative grade point (GPA). Meanwhile, some scholarships have a tendency to assign a higher weight to the criteria of parents' income and number of parent's dependent.

There are several steps taken to obtain judgment in determining which students will be given scholarships nor recommended for obtaining a scholarship are as follows :

1. Determine the weight on each criteria, in order to obtain the matrix **W**
2. Create an alternative table that contains the value of each criteria of each individual student who asked to receive scholarships
3. Perform the process of normalizing the decision matrix (**X**) to a scale by comparing the value of all ratings alternatives. At this stage will be generated matrix **R** that contains normalized performance rating of each student on the attributes of the established criteria.
4. Calculate the value of the preference for each alternative (**Vi**) (matrix **V**) by multiplying matrix **R** with matrix **W**
5. Set the recommended students to obtain scholarships

IV.2 System Design

In this system design, a model of the proposed system is presented in modeling logic. This model will describe the data flow diagrams early (Diagram Context), which will explain to the user how will the functions proposed system of logic will work.

Diagram context for this decision support system are as follows :

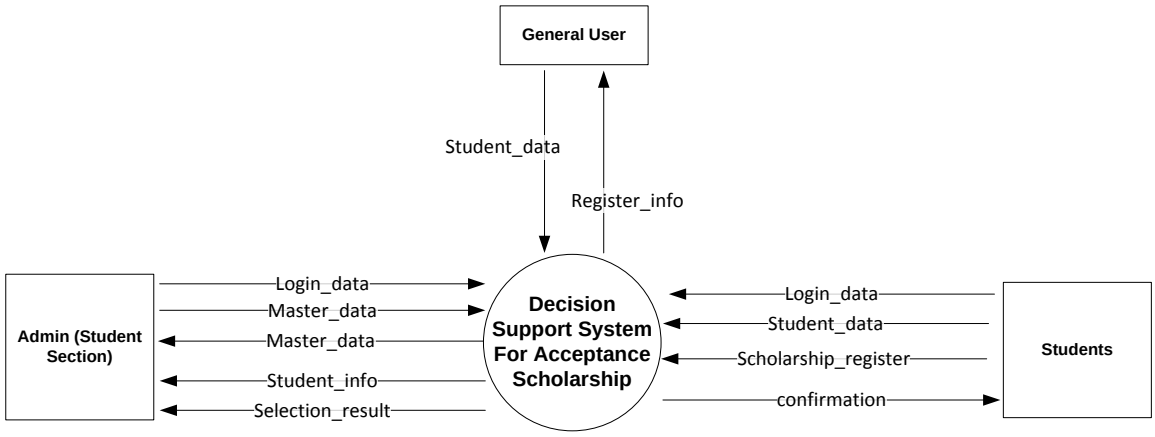

Fig. 1 Context Diagram

The system has three entities: Admin system (student section/ "Bagian Kemahasiswaan"), student and general user. Admin duty required input data, i.e. data types of scholarships available, the data required criteria of each scholarship applicant and the data in this case are students who volunteered as a grantee. Students can log into the system to see scholarships entered and the results of the scholarship selection. General user can register to system and become a student.

V. Implementation

Here implementation of Decision Support System for acceptance scholarships based design that has been proposed :

V.1 Functionality

The following is a list of the functionality of a decision support system with simple additive weighting method built :

Tab. 1 List of Application's Functionality

No	User	Functionality
1.	General User	Register
2.	Student – Admin (Student Section)	Login
3.	Student	View profile
4.	Student	Edit profile
5.	Student	Register fo scholarship
6.	Student	View scholarship has been registered
7.	Student	Delete scholarship has been registered
8.	Admin (Student Section)	Manage user data (Insert, Update, Delete, View, and Search user data)
9.	Admin (Student Section)	Manage scholarship data (Insert, Update, Delete, View, and Search scholarship data)
10.	Admin (Student Section)	Manage criteria data (Insert, Update, Delete, View, and Search criteria data)
11.	Admin (Student Section)	Manage student data (Insert, Update, Delete, View, and Search student data)
12.	Admin (Student Section)	Register scholarship from student
13.	Admin (Student Section)	Delete scholarship registered by student
14.	Admin (Student Section)	Weight criteria setting for each scholarship (Insert, Update, Delete and View criteria for each scholarship)
15.	Admin (Student Section)	Selection scholarship acceptance by SAW Method
16.	Admin (Student Section)	View detail selection
17.	Admin (Student Section)	Scholarship's report
18.	Admin (Student Section)	Student's report
19.	Admin (Student Section)	Report of scholarship register by student
20.	Admin (Student Section)	Acceptance scholarship's report

This is screenshoot of application that built :

Fig. 2 Schoolarship Application

V.2 Evaluation

Here is an example of the data entered in the system as well as the calculations performed by the system with a simple additive weighting method. Steps 1-5 as described in the previous section will be explain.

1. Determine the weight on each criteria, in order to obtain the matrix **W**

   C1 = Grade Point Average (GPA)
   C2 = Parent's Earnings
   C3 = The number of Parent's dependent
   C4 = Active In Organizations
   C5 = Achievement

   For each criteria, we can give weight in percentage, such as :

   C1 = 40%
   C2 = 20%
   C3 = 20%
   C4 = 10%
   C5 = 10%

$$\Rightarrow \quad \mathbf{W} = \begin{bmatrix} 0.4 \\ 0.2 \\ 0.2 \\ 0.1 \\ 0.1 \end{bmatrix} \tag{3}$$

   Here is screenshoot of weight on each criteria on application :

Fig. 3 Weight on Each Criteria on Application

2. Create an alternative table that contains the value of each criteria of each individual student who asked to receive scholarships.
   Suppose that there are eight students who signed up to receive a scholarship with criteria data as shown by Table 2. From 8 students below, will be determined three students eligible for scholarship.

Tab. 2 List of Applicant

No	Student ID	Name	GPA	Parent's Earnings	The number of Parent's dependent	Active In Organizations	Achievement
1	111	Arkham	3.43	Rp 3.000.000	4	1	1
2	112	Yogiek	3.75	Rp 2.000.000	4	1	5
3	113	Elida	3.65	Rp 3.000.000	1	1	1
4	114	Nur	3.66	Rp 2.000.000	1	0	0
5	115	Zahri	2.75	Rp 5.000.000	3	1	0
6	116	Soviana	4	Rp 5.000.000	1	0	1
7	117	Lathifah	2.5	Rp 4.000.000	3	1	0
8	118	Rakhman	2.7	Rp 1.000.000	4	1	10

Here is screenshoot of applicant's list on application :

Mahasiswa

Pencarian

Cari Berdasarkan : NIM

Kata Kunci : [?]

Cari

Export Input Data Mahasiswa

Data Mahasiswa

No	NIM	Nama Mahasiswa	IPK	Penghasilan Orang Tua	Tanggungan Orang Tua	Keaktifan	Nilai Prestasi	Aksi
1	111	Arkham	3.43	Rp 3000000	4	1	1	Detail
2	112	Yogiek	3.75	Rp 2000000	4	1	5	Detail
3	113	Elida	3.65	Rp 3000000	1	1	1	Detail
4	114	Nur	3.66	Rp 2000000	1	0	0	Detail
5	115	Zahri	2.75	Rp 5000000	3	1	0	Detail
6	116	Soviana	4	Rp 5000000	1	0	1	Detail
7	117	Lathifah	2.5	Rp 4000000	3	1	0	Detail
8	118	Rakhman	2.7	Rp 1000000	4	1	10	Detail

Fig. 4 List of Applicant on Application

3. Perform the process of normalizing the decision matrix (**X**) to a scale by comparing the value of all ratings alternatives. At this stage will be generated matrix **R** that contains normalized. performance rating of each student on the attributes of the established criteria.

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\underset{i}{Max}\, x_{ij}} & \text{if j is benefit attribute} \\ \dfrac{\underset{i}{Min}\, x_{ij}}{x_{ij}} & \text{if j is cost attribute} \end{cases}$$

- For GPA criteria, the activity of the organization, and achievement is an profits attribute, because higher GPA from student, more active in organization and more achievement received, make bigger possibility of student to be elected.
- parents income and number of dependents is a cost attribute because higher Parent's earnings and more parent's dependent, make getting smaller possibility of student to be elected.

So, from student data above, we can make calculation bellow :

$$r_{11} = \frac{3.43}{\max(3.43;3.75;3.65;3.66;2.75;4;2.5;2.7)} = \frac{3.43}{4} = 0.85$$

$$r_{21} = \frac{3.75}{\max(3.43;3.75;3.65;3.66;2.75;4;2.5;2.7)} = \frac{3.75}{4} = 0.93$$

$$r_{31} = \frac{3.65}{\max(3.43;3.75;3.65;3.66;2.75;4;2.5;2.7)} = \frac{3.65}{4} = 0.91$$

And so on.

Thus, we can obtained matrix R as follows:

$$\mathbf{R} = \begin{bmatrix} 0.85 & 0.33 & 1 & 1 & 0.1 \\ 0.93 & 0.5 & 1 & 1 & 0.5 \\ 0.91 & 0.33 & 0.25 & 1 & 0.1 \\ 0.91 & 0.5 & 0.25 & 0 & 0 \\ 0.68 & 0.2 & 0.75 & 1 & 0 \\ 1 & 0.2 & 0.25 & 0 & 0.1 \\ 0.62 & 0.25 & 0.75 & 1 & 0 \\ 0.65 & 1 & 1 & 1 & 1 \end{bmatrix}$$

Here is Matrix R on aplication :

Matriks Nilai - Normalisasi

R =

0.85	1	0.33	0.1	1
0.93	1	0.5	0.5	1
0.91	1	0.33	0.1	0.25
0.91	0	0.5	0	0.25
0.68	1	0.2	0	0.75
1	0	0.2	0.1	0.25
0.62	1	0.25	0	0.75
0.67	1	1	1	1

Fig. 5 Matrix R on Application

4. Calculate the value of the preference for each alternative (**Vi**) (matrix **V**) by multiplying matrix **R** with matrix **W**

$$\mathbf{V} = \begin{bmatrix} 0.85 & 0.33 & 1 & 1 & 0.1 \\ 0.93 & 0.5 & 1 & 1 & 0.5 \\ 0.91 & 0.33 & 0.25 & 1 & 0.1 \\ 0.91 & 0.5 & 0.25 & 0 & 0 \\ 0.68 & 0.2 & 0.75 & 1 & 0 \\ 1 & 0.2 & 0.25 & 0 & 0.1 \\ 0.62 & 0.25 & 0.75 & 1 & 0 \\ 0.65 & 1 & 1 & 1 & 1 \end{bmatrix} \text{x} \begin{bmatrix} 0.4 \\ 0.2 \\ 0.2 \\ 0.1 \\ 0.1 \end{bmatrix} = \begin{bmatrix} 0.72 \\ 0.82 \\ 0.59 \\ 0.51 \\ 0.56 \\ 0.50 \\ 0.55 \\ 0.86 \end{bmatrix}$$

Here is screenshoot of multiplying matrix R with matrix W on application :

Hasil Akhir SAW

No	NIM	Nama Mahasiswa	Perhitungan	Total
1	111	Arkham	(0.4 x 0.85) + (0.1 x 1) + (0.2 x 0.33) + (0.1 x 0.1) + (0.2 x 1)	0.716
2	112	Yogiek	(0.4 x 0.93) + (0.1 x 1) + (0.2 x 0.5) + (0.1 x 0.5) + (0.2 x 1)	0.822
3	113	Elida	(0.4 x 0.91) + (0.1 x 1) + (0.2 x 0.33) + (0.1 x 0.1) + (0.2 x 0.25)	0.59
4	114	Nur	(0.4 x 0.91) + (0.1 x 0) + (0.2 x 0.5) + (0.1 x 0) + (0.2 x 0.25)	0.514
5	115	Zahri	(0.4 x 0.68) + (0.1 x 1) + (0.2 x 0.2) + (0.1 x 0) + (0.2 x 0.75)	0.562
6	116	Soviana	(0.4 x 1) + (0.1 x 0) + (0.2 x 0.2) + (0.1 x 0.1) + (0.2 x 0.25)	0.5
7	117	Lathifah	(0.4 x 0.62) + (0.1 x 1) + (0.2 x 0.25) + (0.1 x 0) + (0.2 x 0.75)	0.548
8	118	Rakhman	(0.4 x 0.67) + (0.1 x 1) + (0.2 x 1) + (0.1 x 1) + (0.2 x 1)	0.868

Fig. 6 Multiplying Matrix R with Matrix W on Application

5. Set the recommended students to obtain scholarships
   From assessment above, results obtained for each student as follows :

Tab. 3 Selection Result from SAW Method

No	Student ID	Student's Name	Total Result	Information
1	111	Arkham	0.72	Accepted
2	112	Yogiek	0.82	Accepted
3	113	Elida	0.59	Declined
4	114	Nur	0.51	Declined
5	115	Zahri	0.56	Declined
6	116	Soviana	0.50	Declined
7	117	Lathifah	0.55	Declined
8	118	Rakhman	0.86	Accepted

Here is screenshoot of final result on application :

Hasil Penilaian Simple Additive Weighting

No	NIM	Nama Mahasiswa	Nilai Total	Status
1	118	Rakhman	0.868	Diterima
2	112	Yogiek	0.822	Diterima
3	111	Arkham	0.716	Diterima
4	113	Elida	0.59	Ditolak
5	115	Zahri	0.562	Ditolak
6	117	Lathifah	0.548	Ditolak
7	114	Nur	0.514	Ditolak
8	116	Soviana	0.5	Ditolak

Fig. 7 Final Result on Application

VI. Conclusion

1. Decision Support System Model with Simple Additive Weighting (SAW) method was evidenced to be useful and valid in the case of scholarship recipient selection process.
2. In applying Simple Additive Weighting (SAW) method, the assessment criteria and their respective weighting should be determined in advance to obtain the final score of each candidates by is using matrix multiplication.

References

[1] Ekasari, and Husnul. *Perancangan Sistem Pendukung Keputusan untuk Memantau Kualitas Lingkungan*. 2010.

[2] Gerdon. *Sistem Pendukung Keputusan Untuk Menentukan Penerimaan Beasiswa Bagi Mahasiswa*. 2011.

[3] S. Kusumadewi, S. Hartati, A. Harjoko, and R. Wardoyo. *Fuzzy Multi-Attribute Decision Making (FUZZY MADM).* Yogyakarta : Penerbit Graha Ilmu. 2006.

[4] R. S. Pressman. *"Software Engineering : A Practitioner's Approach 6th Edition"*. McGraw – Hill International Edition. Singapore. 2005.