

# **Designing Website-Based Scholarship Management Application for Teaching of Analytical Hierarchy Process (AHP) in Decision Support Systems (DSS) Subjects**

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**Abstract**—Teaching Analytical Hierarchy Process (AHP) in Decision Support Systems (DSS) subjects encourages students to know how a good decision is taken. AHP itself in the field of education and teaching has been widely used as an effective and efficient method in solving educational problems. The purpose of this paper is to designing website-based scholarship management application for teaching of analytical hierarchy process (ahp) in decision support systems (dss) subjects. Scholarship management using AHP is choosing the right criteria is very important. This system uses 5 criteria, namely academic value, academic achievement, non-academic achievement, parents 'income, and parents' dependents, as a basis for producing decision-supporting information. The scholarship management system is embodied in a website-based computer application. Utilizing this application provides more assistance to donors, so that the results of this learning are not only proven in theory but also in practice in real conditions. In addition, the Website-Based Scholarship Management Application can be run on a mobile basis and can be accessed wherever and whenever they are.

**Keywords**—Scholarship, Website Based Application, Teaching Analytical Hierarchy Process, Decision Support System.

## **1 Introduction**

Decision making is a difficult task. This task has a significant impact on these decision makers [1]. These impacts can be in the form of good or bad impacts, according to the accuracy in choosing the time, atmosphere, place and the decision itself. This is because every decision has consequences [2, 3]. The emergence of these consequences is influenced by various factors in the decision-making process. This factor gives consideration to decision makers, and it often makes them uncertain in making these decisions [4]. For this reason, there are many ways to help decision makers in making decisions, including the use of Decision Support Systems [5, 6].

Decision Support Systems (DSS) is a tool that can assist decision makers in providing recommendation information that runs on a computer application [7, 8]. As

in the field of education in research [9], in selecting outstanding students, then in the health sector in research [10], in helping to make decisions on the number of biomarkers and therapeutics in administering drugs to patients [11], then in the field of social as in research [12], in choosing employees to be promoted and more. Some of these studies show that DSS is used to help solve a semi-structured problem. Where this semi-structured problem occurs in a predictable or recurring time span, so the resolution procedure can be patterned using a method [13]. There are many types of methods used in DSS, such as the Analytic Hierarchy Process (AHP) method developed by Saaty [14].

The AHP method is a decision support system method that describes complex problems into several simpler levels of hierarchical problems, making them easier to analyze in the system being built [15, 14]. The first level in the AHP method is the main objective of the DSS, then the second level is in the form of criteria, and the third level is in the form of candidates [15]. In the AHP method, the criteria level data will be used in comparing any information obtained from each candidate in realizing the main goal of helping decision making in solving a problem [16, 17].

The AHP method is very possible to be used for teaching learning in technical education [18], with the characteristics of technical education that requires competency and product-oriented learning [19]-[22], AHP teaching is an alternative solution, including in informatics engineering education in DSS subjects. There are many problem solving that DSS can help in everyday life. For example, the scholarship management problem is a semi-structured problem [23]. The problem of scholarship management occurs repeatedly, which with this iteration forms a pattern that can be processed by the DSS. Where the results of DSS processing can later help donors in choosing to whom to provide assistance [24]. For this reason, this paper will discuss AHP teaching in DSS subjects, with learning outcomes in the form of a website-based scholarship management application.

## **2 Research Methods**

DSS subjects using the AHP method in scholarship management begins with determining criteria. These criteria are obtained from prospective scholarship recipients by setting their priority data. This is so that the information generated can help donors make decisions. The criteria used in this processing are presented in Figure 1.

In Figure 1, there are five data criteria for prospective scholarship recipients used. These five criteria are the basis for determining the priority order of scholarship recipients. These criteria consist of Academic Value (AV), Academic Achievement (AA), Non Academic Achievement (NAA), Parents' Income (PI) and Parents' Dependents (PD). Each criterion in the data for prospective scholarship recipients has a value based on the level of data the scholarship recipient has. The levels are presented in table 1.

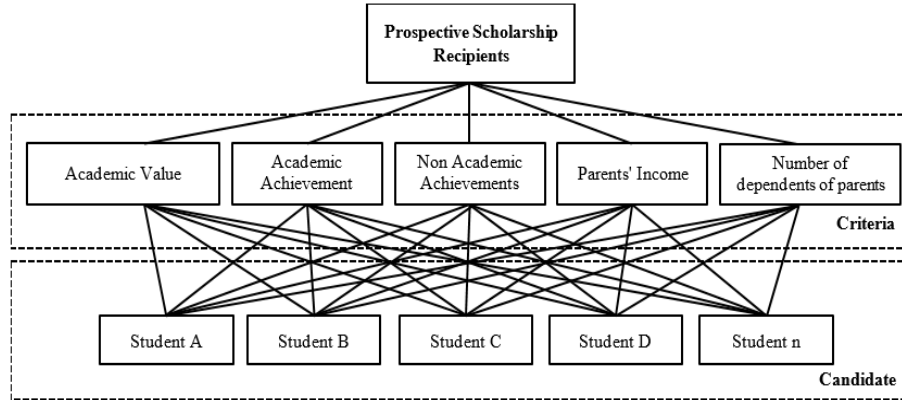


Fig. 1. Criteria for assessing potential donation recipients

Table 1. Value of Data Criteria

Score	AV	AA	NAA	PI	PD
Very Good	GPA > 3.75	International	International	PI ≤ Rp. 1.500.000,-	PD > 5
Good	3.5 < GPA ≤ 3.75	National	National	Rp. 1.500.000 < PI ≤ Rp. 2.000.000,-	PD = 5
Enough	3.25 < GPA ≤ 3.5	Province / City	Province / City	Rp. 2.000.000 < PI ≤ Rp. 2.500.000,-	PD = 4
Less	3.00 < GPA ≤ 3.25	College	College	Rp. 2.500.000 < PI ≤ Rp. 3.000.000,-	PD = 3
Very Less	GPA < 3.00	There is no	There is no	PI > Rp. 3.000.000,-	PD ≤ 2

The data in table 1 provides information that each criterion set is based on the highest to the lowest values. The highest score will get the value of 'Very Good', followed by 'Good', 'Enough', 'Less' and the lowest is 'Very Less' based on the achievement range of values on the predetermined criteria. Each criterion has its own value and priority, the values and priorities are in table 2.

Table 2. Value and Criteria Priority

Criteria	PI	PD	AV	AA	NAA	Value Criteria	Priority Vector	Addition of Each Line	Consistency Ratio
PI	1	2	3	4	5	2,081	0,416	2,129	2,545
PD	0,5	1	2	3	4	1,309	0,262	1,337	1,599
AV	0,33	0,5	1	2	3	0,805	0,161	0,815	0,976
AA	0,25	0,33	0,5	1	2	0,493	0,099	0,495	0,594
NAA	0,2	0,25	0,33	0,5	1	0,312	0,062	0,314	0,376
Total	2,28	4,08	6,83	10,5	15	5,00	1,00		6,090

Table 2 starts from the comparison between each criterion. A comparison using the Saaty scale, namely 1 to 9 to show a synthesis of priority [25]. As in the criterion PI

with PD which has a ratio of 1 to 2, which means that PI is 2 times more prioritized than PD and so on. The explanation of this comparison value scale is described in table 3. The calculation is continued to calculate the value of each criterion by formula (1). This value is intended to calculate the portion of the value of each criterion used with a maximum of five according to the number of criteria used.

The calculation is continued by calculating the value of the Priority Vector to find out the portion of the priority value for each criterion. The maximum number of all portions of the priority value is one, which is obtained from the calculation using the formula (2). The calculation is continued by adding up each criterion row with formula (3) and then calculating the consistency ratio for each line (partial) with formula (4). After obtaining the consistency ratio value partially, the calculation is continued to obtain the consistency ratio value simultaneously with formula (7).

$$k = \sum(n / \sum n) \dots\dots\dots (1)$$

$$PV = k / \sum k \dots\dots\dots (2)$$

$$PS = \sum(n * PV) \dots\dots\dots (3)$$

$$RK = PV + PS \dots\dots\dots (4)$$

$$\lambda \max = \sum k + \sum RK \dots\dots\dots (5)$$

$$CI = \lambda \max + \sum k \dots\dots\dots (6)$$

$$CR = CI / IR \dots\dots\dots (7)$$

Description

- k = Criteria
- n = Value on the Criteria
- PV = Priority Vector
- PS = Addition of Each Line
- RK = Consistency Ratio
- $\lambda$  Max = Maximum Lamda
- CI = Consistency Index
- CR = Consistency Ratio
- IR = Index Random Consistency

**Table 3.** Saaty Comparison Scale

Scale $a_{i,j}$	Description
1	The two criteria are equally important.
3	The criteria $i$ , is somewhat (weak) more important than criteria $j$ .
5	The criteria $i$ , is sufficiently (strongly) important than criteria $j$ .
7	The criteria $i$ , is very (very strong) important than criteria $j$ .
9	The criteria $i$ , has extreme importance (absolutely) from criteria $j$ .
2, 4, 6, 8	The criteria $i$ , and $j$ have a mean value between two adjacent decision values.

Source: [25].

In the calculation using the formula (7), the final value obtained from the Consistency Ratio (CR) simultaneously is -0.85 with CI -0.945 and IR 1.12. The CR value of -0.85 is smaller than 0.1 (10%), which means that the CR value in the ratio of the

portion of each criterion used is consistent [26]. After the main criterion value is obtained, it is followed by the calculation of the sub-criterion value in the same way of calculating the main criterion value. The results of the calculations of the five main and sub-criteria are presented in table 4.

**Table 4.** Value of Main Criteria and Sub Criteria

Criteria	AV	AA	NAA	PI	PD
Value	0.161	0.099	0.062	0.416	0.262
<i>Value of Sub Criteria</i>					
Very Good	1	1	1	1	1
Good	0.509	0.694	0.545	0.604	0.471
Enough	0.312	0.445	0.216	0.347	0.335
Less	0.186	0.310	0.139	0.147	0.186
Very Less	0.144	0.190	0.104	0.095	0.093

In table 4, the sub-criterion value shows the portion of each main criterion, if compiled all the values of the sub-criteria will get a maximum value of 1 (100%). In the main criteria, AV has a portion of the value 0.161 (16.1%) of the total value, which if an AV data gets the sub-criteria 'Very Good' then it will get a value of 1. The value 1 has a portion of the maximum value on AV's main criterion, namely 16.1 %. But if the AV sub-criteria are in the range of 'Good' to 'Very Less', then the value on AV will be multiplied by the value of the portion.

For example, if the data on the AV sub-criterion is 'enough', then the calculation is  $0.161 \times 0.312 = 0.05$ , which means that the value of AV is 'enough', namely 0.05 (5%) from a maximum of 16.1%. Furthermore, the AA criteria had a portion of 0.099 (9.9%). Followed by the NAA criteria which have a value portion of 0.062 (6.2%), PI criteria which have a value portion of 0.416 (41.6%), and PD criteria which have a value portion of 0.262 (26.2%), which later on if the maximum value obtained from each criterion will get a value of 100%. The value of the main criteria and sub-criteria will later become a reference in providing an assessment of the data of each prospective scholarship recipient which will then be sorted based on the highest score.

Ordering the value of prospective scholarship recipients is intended to assist donors in choosing to whom to channel their assistance. The performance process of the AHP method is described in a flowchart so that each process step in the system can be described clearly and in detail [27]. The process flowchart from the AHP method is presented in Figure 2.

The AHP method flowchart starts with students as Prospective Scholarship Recipients (CPB) data entry. After that the data is processed by the AHP method, starting from the definition of variables, namely the compilation of data ( $z[]$ ) and (a) as parameters ( $z[]$ ) starting from 0. Followed by giving weights according to the Data Criteria Value (NKD) and Sub Value. Criteria (NSK) on CPB data. The results of the assessment are stored temporarily in the data compilation ( $z[]$ ) and the value of variable a is added to 1. When the CPB data is equal to 0 or does not exist anymore, the data is stored in the database (DB). However, if the CPB data is still there, the loop is

repeated. The data stored in the DB are then presented in the form of priority order information to help donors. Data on DB is also given to CPB in the form of information on donations and donors.

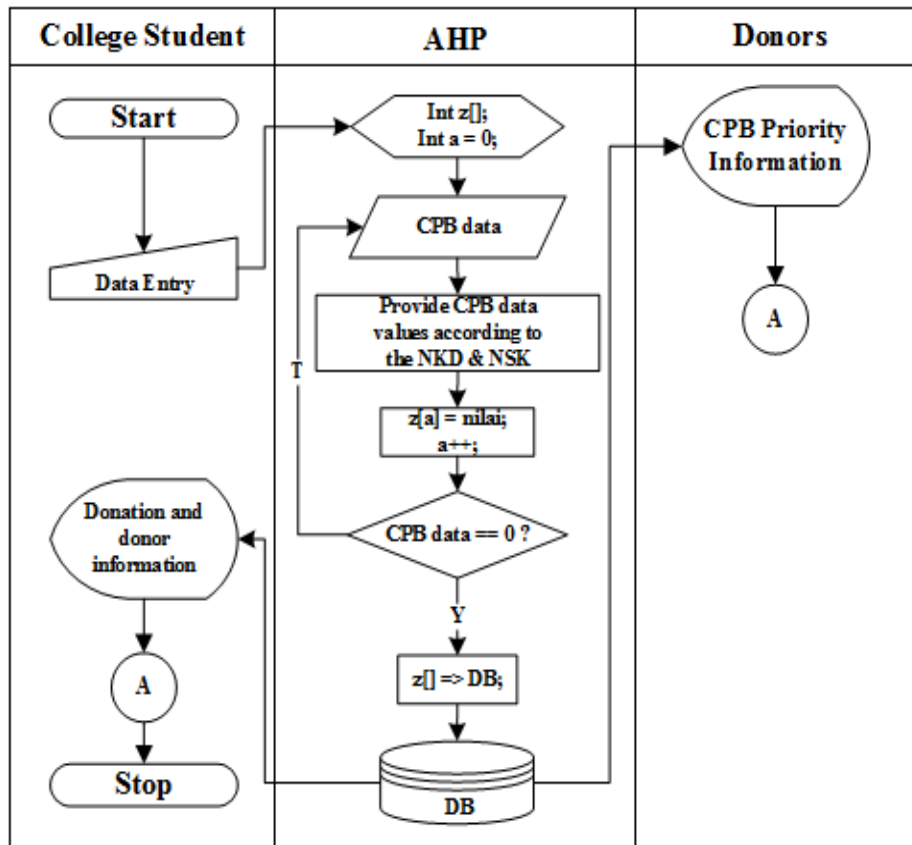


Fig. 2. AHP Method Flowchart

### 3 Implementation and Results

AHP learning outcomes in DSS subjects are implemented in a website-based scholarship management application. This scholarship management application is called the Foster Parents Electronic Application or abbreviated as e-ORA. The design of this e-ORA application uses the AHP method, in which the information generated aims to help donors. The results of this learning are presented in Figure 3.

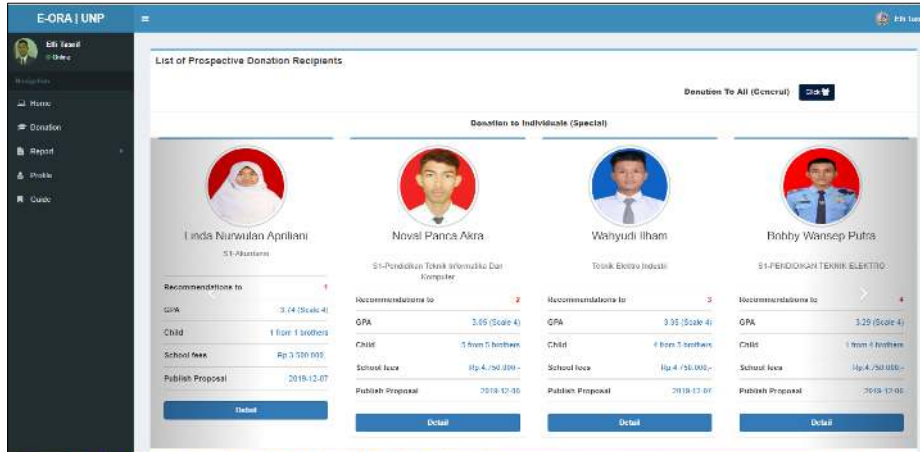


Fig. 3. Results of the implementation of the AHP method in the e-ORA application

The figure 3 shows the results of the implementation of the AHP method which produces information on the priority order of the CPB, namely students. The order of priority is presented from the first to the last priority which is equipped with student identity data. This priority is based on the data they have. Priority information will be intended to assist donors in choosing to whom to donate their assistance. Apart from the order of priority, further information is also provided to potential donors. The information is presented in Figure 4.

The figure 4 presents general student information. This information is in the form of the name, gender, date of birth, study program, semester, GPA, achievement, and evidence files to support this information. Meanwhile, student donor data will also be displayed. The display of donor data is presented in Figure 5.

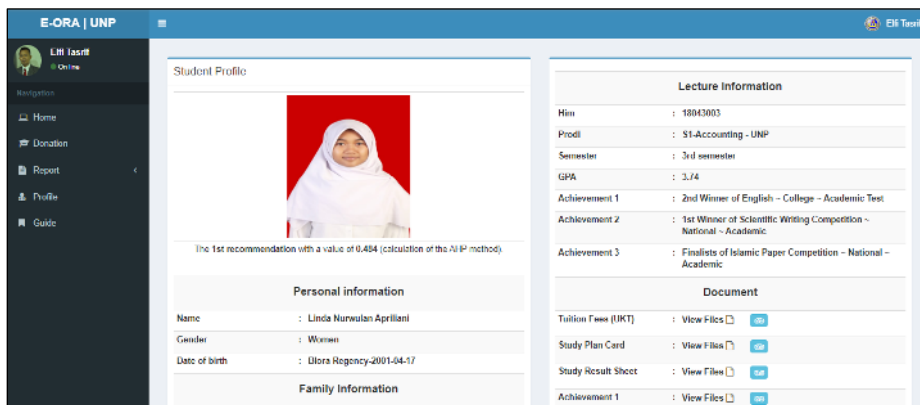


Fig. 4. Student Information



Fig. 5. Donor Information

On the donor information page, the information displayed is the name, gender, place, and date of birth, telephone number, email, occupation, and the donor's statement which contains a message that they are ready to give donations or scholarships to the student concerned. This information will appear to students if the donor agrees that their information is displayed to students otherwise, this information will not be displayed to students.

## 4 Discussion

AHP itself in education and teaching has been widely used as an effective and efficient method in solving educational problems [28]-[30]. AHP teaching in DSS subjects encourages students to know how a good decision is taken [31]. This knowledge is further developed by utilizing one of the DSS methods, namely AHP [22], in assisting decision making which is implemented in scholarship management. In scholarship management using AHP is choosing the right criteria is very important [32]. As in research scholarship using AHP [33], which uses several criteria, namely academic achievement, non-academic achievement, personality, mileage, report cards, organization, parent's dependents, parental income, and parental status in scholarship management. In research DSS for scholarship [34], in the selection of scholarship recipients using the criteria for majors, parental income, parental responsibility, academic achievement, student non-academic achievement.

In research [35], choosing the right scholarship recipients, they used the criteria for economic ability, academic achievement, organizational activeness, and student non-academic achievement. For this reason, from several criteria that have been presented, 5 criteria are taken which are the basis for this AHP teaching. The criteria used are academic value, academic achievement, academic achievement, parents' income, and the student's parents' dependents. The selection of these criteria is based on the assumption that these criteria can provide a distinguishing value for each student and can represent their condition accurately. Processing data from each criterion using



AHP produces information that is then presented in a website-based computer application, which aims to be more effective [36, 37]. So AHP learning in this learning, besides producing data calculation results [38, 39], also produces a product in the form of a scholarship management application that provides more value, this learning outcome is in line with the demands of learning in technical education [40], which is product-oriented has the commercial potential [41].

## 5 Conclusion

The challenges of learning in engineering education in the era of globalization of communication technology and the economy require students to be more active, think critically, think creatively, and collaborate. More concrete learning with case studies is needed nowadays. AHP learning in DSS subjects provides a different learning atmosphere. Students are not only taught in making the right decision but also able to make a system to support the decision making. So that this learning process helps shape student competencies in engineering education, including students in informatics engineering education. In addition, the products produced and manufactured using the AHP method for scholarship management have been successfully realized in a website-based computer application. Utilizing this application provides more assistance to donors so that the results of this learning are not only proven in theory but also in practice in real conditions.

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