A support system for accepting student assistance using analytical hierarchy process and simple additive weighting

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Abstract. The Government through the Ministry of Religious Affairs provides assistance to disadvantaged students through the BSM (Indonesian Cash Transfer Programme for Poor Students) program. BSM is in the form of giving some cash to students from various levels of education such as Madrasah Ibtidaiyah (MI), Madrasah Tsanawiyah (MTs), Madrasah Aliyah (MA). BSM recipients come from disadvantaged families who have been selected through various criteria determined by the Ministry of Religious Affairs through schools. Schools still find it difficult to determine which students are eligible to receive BSM, hence to help the school in making decision about BSM acceptance, this study will apply the analytical method of hierarchy process and the simple additive weighting method to the decision support system for determining the scholarship to meet the criteria set by the school. Through a combination of analytical hierarchy process and simple additive weighting methods, the determination of prospective beneficiary students by counting the highest weight through a combination of both uses 5 criteria and 26 alternatives in the decision support system can be done. The purpose of this study is to create a decision support system based on the user-centered design oriented to all user needs, therefore the user can determine the system model used. Users can map an interactive system with various modules that are used through the implementation of user-centered design to produce a useful system and in accordance with the objectives. The results of this study are recommendation of decision support system for disadvantaged students to help with a combination of AHP and SAW of 5 (five) criteria and 26 alternatives used and oriented to the user.

1. Introduction
The Indonesian Cash Transfer Programme for Poor Students (BSM) is one of the government's efforts through the Ministry of Education and Culture in improving the quality of education in Indonesia, especially to students who come from disadvantaged families as a refinement of the Smart Indonesia program. Since the program itself is one of the government programs to spread education in Indonesia [1], it is expected that with the existence of this program it will be able to increase the number of students or students participation and moreover, improve the quality of education itself [2]. In accepting BSM, students are not only seen from the criteria such as having KPS (Social Protection Card), having a Certificate of Disability (SKTM) from the Village, are orphans, having physical disability (normal or less normal) and their parents are registered as participants of the PKH (Program Keluarga Harapan). However, to get a scholarship, the school will create a questionnaire where it contains a list of items owned at home.
One way to organize various criteria established to be used in determining the recipients of BSM is by using a decision support system. Recognizing the importance of determining student recipients, a decision support system is needed to obtain students who will receive scholarship. It is hoped that by building a computerized decision support system, subjectivity in decision making can be minimized and can be replaced with the implementation of all criteria, therefore truly appropriate scholarship recipients will be selected [3]. This scholarship will later be distributed through schools to students who really need it.

Some researches related to this research include the research [4] that create a decision support system with the TOPSIS method for selecting new college students admission scholarship pathways using 7 (seven) criteria with each criterion has a different weight and the research [5] that implements the fuzzy inference system with the tsukamoto method in determining river water quality, where the tsukamoto method is used to classify river water into 4 categories using 7 (seven) parameters. The final results show that of the 60 data used and tested, 90% prove the similarity of calculations result using Tsukamoto fuzzy and those with STORET method calculations. There is also research [6] that combines two methods in a decision support system. The combination of analytical hierarchy process and simple additive weighting is used to determine the priority of developing underwater tourism areas using five criteria and 28 alternatives. The recommendation results are used by the government to determine areas that have tourism potential to be developed with the highest total score of 0.9888. Research [7] combines the TOPIS and SAW methods in the selection of lecturer research proposals where the recommendations are used by reviewers in determining which research is eligible for research funding. This study uses 5 criteria and 20 alternatives with 100% conformity between manual and decision support system calculations.

2. Literature Review

Decision support system (DSS) is an interactive information system that provides a recommendation for a problem by organizing various criteria used [8]. Computerized information systems that support the activities of making a decision by accommodating criteria or information are also called decision support systems [9]. By this means a decision support system must be computer based and the decision results are used as recommendations of problem solving abilities. The decision making process consists of:

- Intelligence to find information or criteria to produce decisions
- Design to make, develop, and analyze the decisions that will be taken
- Choice to choose the decisions that are available and determine which decisions will be done
- Implementation is a recommendation which decisions will be taken to solve the problem

Processes A through C are the first steps in decision making, which ends with a recommendation. The recommendation will be used in process D, where a recommendation is implemented to solve a problem. To find a solution to a problem, criteria are used as a determinant of the weight value, which will be sought for alternatives with the highest weight of the selected alternatives [10]. The method that applies the weighted sum with the concept of finding alternatives by calculating the weight of each criterion on all attributes is called the Simple Additive Weighting (SAW) method. The decision matrix (X) is first normalized to a scale that can be compared to all the weights criteria used as the initial process of simple additive weighting [11].

\[
R_{ij} = \left( \frac{X_{ij}}{\max_i X_{ij}} \right) - \left( \frac{X_{ij}}{\min_i X_{ij}} \right) \tag{1}
\]

Where \( R_{ij} \) is the value of a normalized performance rating, \( X_{ij} \) is the value of the attributes owned by each criterion used; \( \max_i X_{ij} \) is the largest attribute value, while \( \min_i X_{ij} \) is the smallest attribute value of the criteria used in weighting.
\[ Vi = \sum_{j=1}^{n} W_j R_{ij} \]  

Where \( Vi \) is the final value of each alternative calculated, \( W_j \) is the weight of each criterion that has been determined in value, and \( R_{ij} \) is the matrix / value of the normalized work rating [7].

The steps of the SAW method, namely:
- To determine the decision matrix by first determining the criteria to be used.
- To determine the decision normalization matrix by determining the suitability rating of each alternative to the criteria used.
- To determine the weighted decision normalization matrix based on an equation that has been adjusted to the attributes used.
- To calculate weights for each alternative.
- To determine the chosen alternative with the highest weight.

Besides using simple additive weighting method, this research also uses analytical hierarchy process method. Analytical Hierarchy Process is a decision making method that provides a systematic solution and minimizes inconsistencies in judgment [8]. AHP is able to find out the incompatibility in weighting without the need for mathematical calculations [8]. Stages in AHP [12], namely:
- The first stage in the AHP process is to determine the final goal of the decision to be taken.
- The second stage of the AHP process is to arrange the elements involved in the criteria, sub-criteria and alternatives used during the decision making process.
- The next stage is making a paired comparison matrix of each element involved in each group by determining the weight of each criterion oriented towards the final goal.
- Furthermore, the results of the pairwise comparison matrix are needed to determine the value of the eigenvector and its total. The value of the number of eigenvectors is taken from the overall value of each vector that corresponds to the lowest level of the decision making hierarchy [13].

It starts with normalizing each column \( J \) in matrix \( A \):

\[ \sum_i a(ij) = 1 \]  

Then calculate the average value of each row \( I \) in matrix \( A \):

\[ Wi = \sum_i n (ij) \]  

The final stage in AHP is the evaluation of each alternative used based on the value of the weighting criteria by checking the consistency of the AHP process hierarchy [14].

To calculate the consistency value of a weight vector:

\[ (A)(w^T) = (n)(w^T) \]  

To calculate the consistency index:

\[ Ci = \frac{r-n}{n-1} \]  

To calculate consistency ratio:

\[ CR = \frac{Ci}{Ri n} \]  

Decision support system that will be made oriented to the needs of users [15]. The User Centered Design (UCD) method defines all user needs into a system development method [16]. UCD stages [17] include:
- The first stage is determining the prospective system users to be created.
• The second stage is the identification of user needs obtained by interviews, observations on research objects and study of literature related literature.
• The next stage is the analysis of all user needs which are translated into the design of the problem solving model and the application design along with the modules that must be made according to the user's order.
• The fourth step is to implement the design into the system and consult the user for evaluation. Evaluation results are used to improve the system. Iteration usually occurs at this stage because there are some undefined user needs.
• The final stage is when system repairs are re-consulted with the user, therefore the user knows about the system improvements and can control the making of the system to suit all his needs.

All the User Centered Design (UCD) processes involve the user in developing the system; therefore, the user can control and submit suggestions regarding the user interface of the decision support system of scholarship acceptance in school. The user interface is an appropriate application that can improve user experience in interacting with the system; therefore, decision making can be carried out appropriately [18].

3. Method
The system development used in this study is user centered design (UCD). Figure 1 explains that research begins with a literature study that is gathering materials needed to support the research process [19]. This stage is done by gathering the materials needed in this study. The next step is choosing decision support system methods that would be appropriate to solve the problem of scholarships acceptance through the study of existing research journals [17] and determining the most appropriate system development method which is carried out to make this decision support system, because the school is the one that will use the most appropriate system development method and it is oriented towards the end user [20].

All user needs are translated into the system, where the decision support system is created to help the school determine the recipients of the scholarship, according to the highest criteria weights. Detailed list of user needs is obtained through interviews with schools and library research. Creating user interface design is done by inputting all user needs, ranging from making a data flow diagram of a decision support system to creating a database [21]. The last stage in this process is the evaluation of the user about the decision support system that has been made [22]. It must be adjusted to the desires and needs of the user or still be improved using feedback/input from the user [23].

![Figure 1. Research Method](image-url)

Evaluation is a very important phase, which ensures an application is useful and easy to use. It is the key to successful implementation of an application [18]. With the evaluation the user can provide input as material to improve the system until all user needs are defined in the system modules and there is no improvement that must be done anymore.
The AHP method calculation process uses 5 criteria, namely C1 to C5 with 26 alternatives in BSM recipient selection. Figure 2 shows the hierarchy of the AHP process where the final goal of this decision support system is the scholarship recipient selected through 5 criteria.

![Figure 2. AHP Process Hierarchy](image)

Interactive information systems to support the selection of scholarship disadvantaged recipients is designed and built to help the school determine the prospective scholarship recipient students who truly deserve it. The information presented is in the form of a desktop application containing data about the criteria used to determine the recipients of BSM, data on prospective scholarship recipient children and the results of this decision support system, namely the list of children who are eligible to receive scholarships.

4. Result and Discussion

This stage is to identify all user needs that are gained in the system development process through interviews with relevant parties to dig up information. The results of interviews with parties involved with this research, such as schools and prospective scholarship recipient students and literature studies to find some needed references, Data/information obtained, is alternative data, criteria data and weight values used to select scholarship recipients for disadvantaged students.

Several criteria are used in the BSM selection process, namely the prospective BSM recipient student who are being proven as financially disadvantaged by letters from RT, RW and Village students. The second criterion is the BSM orphan recipient, prospective recipient students who have a valid Social Protection Card, have a physical disability, and are participants of the family expectation program from the Ministry of Social Affairs as it proved by PKH cards / supporting documents. From these criteria, different weight values are given according to the provisions of the school as the organizer of the scholarship program.

The combination of analytical hierarchy process method and simple additive weighting method in the scholarship acceptance selection process cannot be shown in Figure 3, starting with determining the final goal of this selection process, that are BSM recipient students, then alternative data in the form of 26 students who will participate in BSM acceptance selection. Determination of criteria and the value of criteria weights still use the AHP method, and the pairwise comparison matrix is determined with the AHP. The SAW method is used for making the decision matrix and normalizing the matrix. The last stage of the SAW method is alternative ranking. The final result was chosen using alternative with the highest weight.
Here are weighting criteria for prospective scholarship recipients which use a combination of 2 (two) methods, namely the analytical hierarchy process method and the simple additive weighting method, with the criteria shown in Table 1 and the calculation of the criteria weighting shown in Table 2.

Table 1. Data Criteria

| Criterion code | Information                |
|----------------|---------------------------|
| C1             | Certificate of Disability |
| C2             | Orphan Certificate        |
| C3             | KPS(Social Protection Card)|
| C4             | Physical Disability       |
| C5             | PKH(Hope Family Program)  |

Table 2. Calculation of Weighting Criteria

| Alternatif | C1  | C2  | C3  | C4  | C5  |
|------------|-----|-----|-----|-----|-----|
| A01        | 1,333 | 2   | 2,333 | 1   | 1   |
| A02        | 2   | 1,333 | 1,333 | 1,333 | 2   |
| A03        | 1,667 | 2,333 | 1,333 | 2,667 | 2,333 |
| A04        | 2   | 1,667 | 2,333 | 2   | 2,333 |
| A05        | 1,333 | 2   | 1,333 | 1,333 | 1,333 |
| A06        | 1,333 | 1,667 | 1,333 | 1,667 | 2   |
| A07        | 1,667 | 1,333 | 1,333 | 2   | 1,333 |
| A08        | 2   | 1,333 | 1,333 | 2,333 | 1,333 |
| A09        | 1,333 | 1,667 | 2   | 1   | 1,667 |
| A10        | 2   | 1,333 | 1,667 | 2,333 | 1,333 |
| A11        | 1,667 | 2   | 2   | 1,333 | 2,333 |
| A12        | 1,333 | 2   | 2   | 1,333 | 2   |
| A13        | 1,333 | 1,333 | 1,333 | 1,667 | 1,667 |
| A14        | 2,667 | 1,667 | 2   | 2   | 2   |
| A15        | 1,333 | 1,667 | 1   | 1,667 | 1,667 |
| A16        | 1,667 | 1,667 | 1,667 | 1,667 | 1,667 |
| A17        | 1,333 | 1,333 | 1,333 | 1,333 | 1,333 |
| A18        | 1,333 | 1,333 | 1,333 | 1,333 | 1,333 |
| A19        | 1,333 | 1,333 | 1,333 | 1,333 | 1,333 |
| A20        | 1,333 | 1,333 | 1,333 | 1,333 | 1,333 |
Table 2 shows the weighting calculation using the simple additive weighting method where A shows an alternative that is the prospective student who receives scholarship, while C1 through C5 shows the 5 criteria used for weighting. There are 26 students submitted by the school to receive scholarships. Those 26 students will be selected, and students with the highest weight who are eligible to receive scholarships will be obtained.

![Figure 4. Chart of Weighting Criteria](chart.png)
The matrix above is the result of a decision matrix that has been normalized to the BSM selection decision support system using the SAW method.

Figure 5 shows the interface design of a decision support system for determining scholarships. The criteria and their weights in the form are determined before weighting.

![Form Data Pembobotan Kriteria](image)

**Figure 5. User Interface Design**

Figure 6 is an implementation of the weighting page that displays information about the weighting values of each alternative in the calculation process, by first determining the criteria to be used in weighting, along with the weighting values C1 to C5. Then the results will display the names of the prospective scholarship recipient students.
5. Conclusion

The results of the research that have been carried out are the user-centered design method and a combination of 2 (two) methods, namely analytical hierarchy process and simple additive weighting, have been successfully implemented into the decision support system for scholarship acceptance at the MTs Negeri Gombong. Analytical hierarchy process calculation and simple additive weighting have succeeded in selecting students who are entitled to receive BSM scholarships, with the highest weighting value. The user-centered design method has successfully mapped all user needs in the creation and development of a system that already contains all the system requirements of the MTs Negeri Gombong school.

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