



Artikel

Decision Support System for Scholarship Selection Using Profile Matching

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SUBMISSION TRACK

Received : 25 July, 2022

Final Revision: 10 August, 2022

Available Online: 24 August, 2022

KEYWORD

Decision Support System, Interpolation, Profile Matching, Scholarship

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A B S T R A C T

Education is very necessary in social life. Education has a role that will improve the quality of resources to be able to have the competencies needed in an increasingly advanced and developing era. In education required a fairly large cost. Giving this scholarship will also greatly help someone in pursuing and even getting an education. Scholarships must also be done objectively, not just subjectively. Because the problems that occur when objectively granting scholarships may not be in accordance with the target of the scholarship award. Scholarships must also be given according to the right criteria so that the scholarship grants get maximum results for the administrators and scholarship recipients. The research was conducted using the Profile Matching method with Interpolation at the Indonesian Christian Church Pos Cikoleang, it will require decision makers to determine the weight value for each criterion. The results issued by the system are the congregations that are accepted and rejected in the scholarship application. and the system can provide scholarships with an accuracy rate of 78%.

I. INTRODUCTION

Education has an important role in improving the quality of human resources. In the current era that is increasingly advanced and developing, competent resources are needed for all fields of work. The cause of the lack of competent resources is unequal education, low quality of education or awareness in studying. In fact, there are still many students who think that education is not their need. This can happen due to several factors. It could be because of the assumption that

school is just a waste of time and adds to the burden and pressure of having to study. And it could also be because of economic problems, where parents feel heavy with living dependents and coupled with school fees.

The Indonesian Christian Church (GKI) Pos Cikoleang is present in the midst of society to be able to proclaim faith and works of love, the Church is not only a place to praise and glorify God, but also as a place to build a fellowship of love among human beings. In the context of service and care for the

congregation, the Council and Fellowship Service Agency Indonesian Christian Church (GKI) Pos Cikoleang created a work program to provide scholarship assistance for their congregations. This scholarship assistance program is organized to participate in helping the congregation as a resource to get a proper education.

Scholarships is a form of award given to individuals who get financing outside of their own funding or parents [2]. Scholarship is defined as a form of award given to individuals in order to continue their education to a higher level [1]. With the scholarships given, it can provide opportunities for those who receive them to increase their human resource capacity through education. In the selection process for scholarships, problems often occur because these scholarships are still carried out subjectively which can cause problems in determining the award of scholarships. Therefore, it is necessary to have a system that can assist in determining the right scholarship award. The system is a set consisting of objects, elements, or components that are related to each other to achieve goals efficient and effective [3].

Based on the existing problems, the researcher proposes a decision support system in determining the award of scholarships to the Indonesian Christian Church (GKI) Pos Cikoleang. A decision support system is a computer system that can assist in making decisions to solve semi-structured problems [4]. By using the criteria that have been determined by the fellowship service agency that is responsible for providing scholarships. The method used in this research is profile matching and interpolation.

II. METHODS

3.1 Decision Support System

A decision support system is a computer-based application that combines data and models to assist the decision-making process in solving problems [5]. Taking or making

decisions is a process that people carry out based on the knowledge and information they have. Decisions can be taken from the existing decision alternatives. Alternative decisions can be made with the information that is processed and presented with the support of a decision support system [6]. Decision support systems are made with the following objectives [7]:

1. Assist in decision making on structured problems.
2. Provides support at the manager's discretion and is not intended to replace the manager's function.
3. Increasing the effectiveness of decisions taken is more than improving their efficiency.
4. Computer computing speed allows decision makers to do a lot of computing quickly at low costs.

3.2 Data Collection

Techniques in data collection are the most strategic steps in research, because researchers can get the information and data needed to support the research being carried out. The data collection methods used by researchers in designing a decision support system for scholarships are as follows:

- a. Observation
Observation is a method of collecting data by observing and recording. Researchers made observations by collecting clear data sources related to research on the process of determining scholarship awards.
- b. Interview
The researcher conducted a question and answer session and face-to-face to understand the process of granting scholarships which is directly related to the scholarship awarding committee in the Church.
- c. References
At this stage the researcher conducts a literature study by collecting data obtained by studying, researching, reading books, and journals needed as

material to complete the research conducted.

3.2 Profile Matching

Profile matching is a decision-making mechanism method that is often used in decision-making that there is an ideal level of predictor variables that must be met by the subject under study [8][9][10]. The calculation process in the Profile Matching method begins with defining the minimum value for each assessment variable. The difference between each test data value against the minimum value of each variable is a gap which is then given a weight. The weight of each variable will be calculated on average based on the Core Factor (CF) and Secondary Factor (SF) variable groups. The composition of CF plus SF is 100%, depending on the interests of the user of this method. The calculation is as follows [11] :

$$NCF = \Sigma NC / \Sigma IC$$

Information :

NCF = Average value of core factor,
 ΣNC = Total number of core factor values,
 ΣIC = Number of core factor items.

Secondary factor value can be calculated as follows [11] :

$$NSF = \Sigma NS / \Sigma IS$$

Information :

NSF = Average value of secondary factor,
 ΣNS = Total value of secondary factor,
 ΣIS = Number of secondary factor items.

For the calculation of the total value after grouping the Core Factor and Secondary Factor as follows :

$$Nt = X\% NCF + X\% NSF$$

Information :

Nt = Total Value,
 NCF = Average value of core factor,
 NSF = Average value of secondary factor,
 X% = Entered percentage value.

3.3 Interpolation

Interpolation is a way of determining the value that lies between two known values based on an equation function. Linear interpolation is a way of determining the value that lies between two known values based on a linear equation (equation of a straight line). Linear equations are also called straight-line equations because if the results of linear equations are drawn on graph paper, the curve is a straight line [12][13]. Linear interpolation is based on comparison theory, as shown in Figure 1.

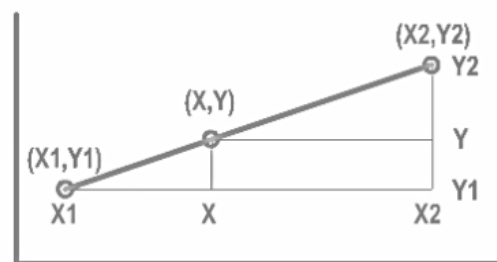


Figure 1 : Linear Interpolation Illustration

Interpolation Calculation :

$$\frac{X-X_1}{X_2-X_1} = \frac{Y-Y_1}{Y_2-Y_1}$$

$$Y = Y_1 + \frac{X-X_1}{X_2-X_1} (Y_2 - Y_1)$$

The ratio of distance $(X - X_1)$ to distance $(X_2 - X_1)$ is the same as the ratio of distance $(Y - Y_1)$ to distance $(Y_2 - Y_1)$. In this way every point that lies between two points known to have a linear relationship will be determined by calculations using the linear interpolation formula.

III. RESULT

In this study, the scholarship award is based on 7 criteria that have been decided by the administrator scholarship at Indonesian Christian Church (GKIS) Pos Cikoleang along with the ideal value of each criterion in table 1:

Table 1. Assessment criteria

Average Value Of Report	Achievement	Parent's Job	Income Parent	Total Dependents	Congregational Status	Attendance in Church for One Year
≥ 75	≥ 3	Not Working	$\leq 1.500.000$	≥ 2	Congregational	≥ 30

After making the ideal value that will be used as a reference for the process of determining the award of scholarships, then grouping 7 criteria into Core Factor and Secondary Factor, can be seen in table 2.

Table 2. Core factor and secondary factor parameters

Core Factor (CF)	Secondary Factor (CF)
1. Average Value Of Report 2. Income Parent 3. Total Dependents 4. Congregational Status	1. Achievement 2. Parent's Job 3. Attendance in Church for One Year

After grouping, the next step is to determine the percentage of parameter values included in the core factor and secondary factor. The percentage of the core factor is 75% and the secondary factor is 25%. This value describes the level of influence of the existence of these parameters on the decision to grant scholarships to the Indonesian Christian

Church Serpong (GKIS) Pos Cikoleang congregation. The greater the percentage, the higher the influence of these parameters on the determination of scholarships.

The scoring is formulated using the linear interpolation method. The value will reach the maximum value when the ideal condition is reached, and an interpolation calculation will be carried out if it is outside the ideal value. In this study, an ordinal value of 5 was used for the maximum value and an ordinal value of 0 for the minimum value. Especially for the parameters of Parent's Job (K3) and Congregational Status (K6), no interpolation calculations were carried out, but using ordinal values because based on the results of consultations with the scholarship giving administrators, the data were in ordinal form. In this study, two forms of curves were used, namely a downward triangular curve and an upward triangular curve. A descending triangular curve or an ascending triangular curve is used if the calculated interpolation value contains two or three interpolation values, as shown in the curve shown in Table 3.

Table 3. Interpolation of Parameter Values for Scholarship Award

Parameter	Kurva	Calculation of Interpolation Value
(K1)		$score(x) = \begin{cases} 5; & x \geq 75 \\ \frac{x-0}{75-0} (5-0) + 0; & x < 75 \end{cases}$
(K2)		$score(x) = \begin{cases} 5; & x \geq 3 \\ \frac{x-0}{3-0} (5-0) + 0; & x < 3 \end{cases}$
(K3)	Not Working	$score(x) = \begin{cases} 5; & x = \text{Not Working} \\ 0; & x = \text{Working} \end{cases}$

(K4)		$score(x) = \begin{cases} 5; & x < 1.500.000 \\ \frac{x-1.500.000}{3.500.000-1.500.000} (0 - 5) + 5; & 1.500.000 > x \geq 3.500.000 \\ 0; & x > 3.500.000 \end{cases}$
(K5)		$score(x) = \begin{cases} 5; & x \geq 5 \\ \frac{x-2}{5-2} (5 - 0) + 0; & x < 5 \end{cases}$
(K6)	Congregational	$score(x) = \begin{cases} 5; & x = 4. \text{Congregational} \\ 0; & x = \text{Sympathizer} \end{cases}$
(K7)		$score(x) = \begin{cases} 5; & x \geq 40 \\ \frac{x-30}{40-30} (5 - 0) + 0; & x < 40 \end{cases}$

Table 3 is a table for calculating the interpolation value for determining the scholarship award. The ideal value for (K1) is ≥ 75 , the ideal value for (K2) is ≥ 3 achievements, the ideal value for (K3) is not working, the ideal value for (K4) $< 1,500,000$ parental income each month, the ideal value for (K5) is ≥ 2 number of dependents, the ideal value for (K6) is the congregation, and the ideal value for (K7) ≥ 30 church attendances. For values above or below the

ideal value, an interpolated value calculation is carried out to get the right score according to the level of proximity to the ideal value. Here are 5 congregations sourced from the Indonesian Christian Church (GKI) Pos Cikoleang as an example of a calculation to determine whether the congregation in applying for a scholarship can be accepted or rejected. The value for each parameter can be seen in table 4 :

Table 4. Congregational Data Apply for Scholarship

Alternative	K1	K2	K3	K4	K5	K6	K7
Congregational 1	82	3	Working	2.000.000	2	Congregational	40
Congregational 2	90	0	Working	1.500.000	1	Sympathizer	30
Congregational 3	80	3	Not Working	0	0	Sympathizer	52
Congregational 4	77	5	Working	800.000	1	Congregational	20
Congregational 5	88	2	Working	1.200.000	2	Congregational	46

Based on the parameter values of the alternatives for each congregation contained in Table 4 it is necessary to calculate the score of the criteria first after obtaining the scoring value, then calculate the average value of each criteria which is grouped into the core factor and secondary factor. The score for the alternative congregation 1 can be seen in table 5 :

Table 5. Alternative Congregation 1

Criteria	Value	Score
K1	82	Score(x) = 5
K2	3	Score(x) = 5

K3	Working	Score(x) = 0
K4	2000000	Score(x) = $\frac{2000000-1500000}{3500000-1500000} (0 - 5) + 5 = 3,75$
K5	2	Score(x) = 5
K6	Congregational	Score(x) = 5
K7	40	Score(x) = 5

After obtaining the interpolation value for each parameter, the average value of core factor (K1,K4,K5,K6) and the average value

of secondary factor (K2,K3,K7) are calculated as follows:

- Average Core Factor

$$NCF = \frac{5 + 3,75 + 5 + 5}{4} = 4,688$$

- Average Secondary Factor

$$NSF = \frac{5 + 0 + 5}{3} = 3,333$$

The total score for alternative congregation 1 is determined by the percentage of 75% core factor and 25% secondary factor, as follows:

$$\begin{aligned} \text{Score} &= (0,75 * NCF) + (0,25 * NSF) \\ &= (0,75 * 4,688) + (0,25 * 3,333) \\ &= 3,516 + 0,833 = 4,349 \end{aligned}$$

The percentage of match conditions for the alternative value of congregation 1 can be calculated as follows = $(4,349/5) * 100 = 86,979$.

The score for the alternative congregation 2 can be seen in table 6 :

Table 6. Alternative Congregation 2

Criteria	Value	Score
K1	90	Score (x) = 5
K2	0	Score (x) = 0
K3	Working	Score (x) = 0
K4	1500000	Score (x) = 5
K5	1	Score (x) = $\frac{1-0}{2-0} (5) = 2,5$
K6	Sympathizer	Score (x) = 0
K7	30	Score (x) = 5

After obtaining the interpolation value for each parameter, the average value of core factor (K1,K4,K5,K6) and the average value of secondary factor (K2,K3,K7) are calculated as follows:

- Average Core Factor

$$NCF = \frac{5 + 5 + 2,5 + 0}{4} = 3,125$$

- Average Secondary Factor

$$NSF = \frac{0 + 0 + 5}{3} = 1,667$$

The total score for alternative congregation 2 is determined by the percentage of 75% core factor and 25% secondary factor, as follows:

$$\begin{aligned} \text{Score} &= (0,75 * NCF) + (0,25 * NSF) \\ &= (0,75 * 3,125) + (0,25 * 1,667) \\ &= 2,344 + 0,417 = 2,760 \end{aligned}$$

The percentage of match conditions for the alternative value of congregation 2 can be calculated as follows = $(2,760/5) * 100 = 55,208$.

The score for the alternative congregation 3 can be seen in table 7 :

Table 7. Alternative Congregation 3

Criteria	Value	Score
K1	80	Score (x) = 5
K2	3	Score (x) = 5
K3	Not Working	Score (x) = 5
K4	0	Score (x) = 5
K5	0	Score (x) = 0
K6	Sympathizer	Score (x) = 0
K7	52	Score (x) = 5

After obtaining the interpolation value for each parameter, the average value of core factor (K1,K4,K5,K6) and the average value of secondary factor (K2,K3,K7) are calculated as follows:

- Average Core Factor

$$NCF = \frac{5 + 5 + 0 + 0}{4} = 2,5$$

- Average Secondary Factor

$$NSF = \frac{5 + 5 + 5}{3} = 5$$

The total score for alternative congregation 3 is determined by the percentage of 75% core factor and 25% secondary factor, as follows:

$$\begin{aligned} \text{Score} &= (0,75 * NCF) + (0,25 * NSF) \\ &= (0,75 * 2,5) + (0,25 * 5) \\ &= 1,875 + 1,25 = 3,125 \end{aligned}$$

The percentage of match conditions for the alternative value of congregation 3 can be calculated as follows = $(3,125/5) * 100 = 62,500$.

The score for the alternative congregation 4 can be seen in table 8 :

Table 8. Alternative Congregation 4

Criteria	Value	Score
K1	77	Score (x) = 5
K2	5	Score (x) = 5
K3	Work	Score (x) = 0
K4	800.000	Score (x) = 5
K5	1	Score (x) = $\frac{1-0}{2-0} (5) = 2,5$
K6	Congregational	Score (x) = 5
K7	20	Score (x) = $\frac{20-0}{30-0} (5) = 3,333$

After obtaining the interpolation value for each parameter, the average value of core factor (K1,K4,K5,K6) and the average value of secondary factor (K2,K3,K7) are calculated as follows:

- Average Core Factor

$$NCF = \frac{5 + 5 + 2,5 + 5}{4} = 4,375$$

- Average Secondary Factor

$$NSF = \frac{5 + 0 + 3,333}{3} = 2,778$$

The total score for alternative congregation 4 is determined by the percentage of 75% core factor and 25% secondary factor, as follows:

$$\begin{aligned} \text{Score} &= (0,75 * NCF) + (0,25 * NSF) \\ &= (0,75 * 4,375) + (0,25 * 2,778) \\ &= 3,281 + 0,695 = 3,976 \end{aligned}$$

The percentage of match conditions for the alternative value of congregation 4 can be calculated as follows = $(3,976/5) * 100 = 79,514$.

The score for the alternative congregation 5 can be seen in table 9:

Table 9. Alternative Congregation 5

Criteria	Value	Score
K1	88	Score (x) = 5
K2	2	Score (x) = $\frac{2-0}{3-0} (5) = 3,333$
K3	Work	Score (x) = 0
K4	1.200.000	Score (x) = 5
K5	2	Score (x) = 5
K6	Congregational	Score (x) = 5
K7	46	Score (x) = 5

After obtaining the interpolation value for each parameter, the average value of core factor (K1,K4,K5,K6) and the average value of secondary factor (K2,K3,K7) are calculated as follows:

- Average Core Factor

$$NCF = \frac{5 + 5 + 5 + 5}{4} = 5$$

- Average Secondary Factor

$$NSF = \frac{3,333 + 0 + 5}{3} = 2,778$$

The total score for alternative congregation 5 is determined by the percentage of 75% core factor and 25% secondary factor, as follows:

$$\begin{aligned} \text{Score} &= (0,75 * NCF) + (0,25 * NSF) \\ &= (0,75 * 5) + (0,25 * 2,778) \\ &= 3,75 + 0,695 = 4,444 \end{aligned}$$

The percentage of match conditions for the alternative value of congregation 5 can be calculated as follows = $(4,444/5) * 100 = 88,889$.

After doing the calculations for 5 congregations who submitted applications to receive scholarships, the results are as follows in table 10.

Table 10. Result of Accepted and Rejected Fellowship Fellowship

Alternative	K1	K2	K3	K4	K5	K6	K7	Results
Congregational 1	82	3	Working	2.000.000	2	Congregational	40	86,979
Congregational 2	90	0	Working	1.500.000	1	Sympathizer	30	55,208

Congregational 3	80	3	Not Working	0	0	Sympathizer	52	62,500
Congregational 4	77	5	Working	800.000	1	Congregational	20	79,514
Congregational 5	88	2	Working	1.200.000	2	Congregational	46	88,889

Table 10 shows the results obtained for each congregation that applied for a scholarship but only 2 congregations were entitled to receive scholarships, including Congregation 1 and Congregation 5. Because it meets the standard value of 80 which has been determined by the scholarship administrator at the Indonesian Christian Church (GKI) Pos Cikoleang.

System Testing with Confusion Matrix

The test results of the proposed model which include the calculation of the value of accuracy, precision and recall show a good performance of the proposed model. The tests were carried out involving the results of decisions from the scholarship awarding

committee and the model of the system created to assist the scholarship administrators in making decisions in this case the system model using profile matching and interpolation methods. Each test was carried out using 70 test data contained in GKIS Pos Cikoleang and also 120 test data contained in the Indonesian Christian Church Serpong as the parent of GKIS Pos Cikoleang. In this test data, there are a total of 190 congregations from GKIS Pos Cikoleang and the Indonesian Christian Church Serpong where 65 congregations were accepted for the scholarships determined by the management and 125 were rejected. Meanwhile, the system yielded 47 congregations who were right to receive scholarships.

Figure 11. Confusion Matrix Testing Results

		Actual Label	
		Accepted	Rejected
Predicted Label	Accepted	47	23
	Rejected	18	102

The accuracy value of the confusion matrix is as follows:

$$\begin{aligned}
 Accuracy &= \frac{TP + TN}{TP + TN + FP + FN} \\
 &= \frac{47 + 97}{47 + 97 + 28 + 18} \\
 &= \frac{149}{190} = 0,78 \\
 &= 0,78 * 100 \\
 &= 78\%
 \end{aligned}$$

The precision value of the confusion matrix is as follows:

$$Precision = \frac{TP}{TP + FP}$$

$$\begin{aligned}
 &= \frac{47}{47 + 23} \\
 &= \frac{47}{70} = 0,67 \\
 &= 0,67 * 100 \\
 &= 67\%
 \end{aligned}$$

The recall value of the confusion matrix is as follows:

$$\begin{aligned}
 Recall &= \frac{TP}{TP + FN} \\
 &= \frac{47}{47 + 18}
 \end{aligned}$$

$$= \frac{47}{65} = 0,72$$

$$= 0,72 * 100$$

$$= 72\%$$

The results of the test are the system can answer correctly by 78% the correct prediction rate for the congregations who will get scholarships and those who do not receive scholarships from the data of 190 congregations as trial data.

IV. CONCLUSION

Based on the implementation and evaluation, can concluded:

- 1 This study resulted in a suitability model for determining the award of scholarships

at the Serpong Indonesian Christian Church (GKIS) Pos Cikoleang based on filling out the scholarship application form using Profile Matching and interpolation methods.

- 2 Based on the results of the evaluation and testing of the scholarship system using profile matching and interpolation methods to the proposed model, the accuracy value is 78%, precision is 67% and recall is 72%.

Suggestions for further research are the application of other methods besides the profile matching method to be able to further increase the accuracy value by increasing the parameters in determining the award of scholarships.

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BIOGRAPHY

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