

# DSS For Scholarship Recipients Using The Fuzzy C-Means Clustering Integrated With The Simple Additive Weighting Method

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**Abstract**— Determination of scholarship recipients is a very subjective and complicated thing to do without using information systems. Therefore, this paper presents the development of a decision support system for determining scholarship recipients using the fuzzy c-means clustering (FCM) method with the integrated, simple additive weighting method conducted at the College of Technology Nusa Putra. The assessment is conducted by determining the grouping, which then calculates the XB (Xie-Beni) index for each cluster that has been formed. From these calculations, it is known which group is the best that can be used as an alternative for decision making. The ranking process of each cluster determines the optimal option of the best prospective student scholarship recipients. The results of this study indicate that scholarship recipients at the College of Technology Nusa Putra are more objective and make more precise and efficient decisions.

**Index Terms**— fuzzy c-means clustering, simple additive weighting, decision-making systems, scholarships.

## 1 INTRODUCTION

In the current era of globalization, technological developments are increasing rapidly where information is the main factor needed by the public in following the latest news developments [1, 2]. Knowledge can never be delivered to all members of the public if the required data is not obtained wholly, and the processing of the data is not carried out correctly. That causes the information submitted to be inaccurate [3]. Information technology science is one of the disciplines that can overcome these problems in processing data to be presented as information. The day the science is growing, so it requires patience for information processors to follow its development so that the information conveyed to users is perfect information. The College of Technology Nusa Putra as one of the colleges in Sukabumi, West Java, Indonesia, there is a lot of information that must be delivered to the organizational structure. However, there are often inaccuracies in providing information so that errors in decision making often occur. Decision making is a systematic approach to the nature of a problem, gathering facts, a mature determination of the alternatives faced, and taking action which, according to the calculation, is the most appropriate action. On the other hand, decision making is often faced with the complexity and scope of decision making with so much data. For this reason, most decision-makers taking into account the benefit/cost ratio, are faced with a necessity to rely on a set of systems capable of solving problems efficiently and effectively, which is then called a decision support system. Some researchers have used the ANN method [4-6], linear regression [7], and SOA [8] to initiate decision-making systems. But what is developing now is the use of fuzzy logic in decision support systems. Fuzzy logic is a component of soft computing. Prof. Lotfi A. Zadeh first introduced fuzzy logic in 1965 [9, 10]. The basis of fuzzy logic is the theory of fuzzy sets. In fuzzy set theory, the role of the degree of

membership as a determinant of the existence of elements in a collection is crucial. The degree of the group becomes the main characteristic of reasoning with fuzzy logic. In fuzzy set theory, it will provide an answer to a problem that contains uncertainty. In some exceptional cases, such as the membership value which will then become "0" or "1", the underlying theory will be identical to the ordinary set theory, and the fuzzy set will be the traditional crisp set. Fuzzy size shows the degree of blurring of the fuzzy set. The degree/blur index is the distance between a fuzzy set "A" and the nearest crisp set "C" [10]. Fuzzy c-means clustering (FCM) is a data clustering technique in which the existence of each data point in a cluster is determined by the degree of membership of the FCM using a fuzzy grouping model with blurring indices using Euclidean Distance so that the data can be a member of all classes of a cluster – formed with a degree of membership that is between 0 to 1. The basic concept of FCM first is to determine the center of the cluster that will mark the average location for each group. In the initial condition, the cluster center is still inaccurate. Each data point has a degree of membership for each group that is formed. By improving the cluster center and the degree of membership of each data point repeatedly, it will be seen that the cluster center will shift to the right location. This iteration is based on the minimization of objective functions that describe the distance from the data point given to the center of the cluster weighted by the degree of membership of that data point. Because some of the problems obtained from the delivery of information at the Nusa Putra High School of Technology, this paper presents the development of an information system for decision making in determining which students are eligible to receive scholarships from this tertiary institution. The computational method is based on the decision support system method. The system integrates the fuzzy c-means clustering method with the simple additive weighting method.

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## 2. RESEARCH METHODOLOGY

### 2.1 Method of Sample selection

The sample selection method used by the author in this study is random sampling, which is the process of selecting samples where all members of the population have the same opportunity to be chosen and the random sampling method used is stratified random sampling. In this study the sampling referred to is the sampling of scholarship applicants who have registered at the Nusa Putra High School of Technology to be investigated to produce a decision making system using a decision support system with the integration of the fuzzy c-means clustering (FCM) method and the simple additive method weighting which will then be tested for accuracy by comparing the results of decisions made by the selectors and those recommended by the system.

**Table 1. Scholarship program applicant data**

Name	High school test scores	Parents' income (IDR × 10 <sup>6</sup> )	Number of dependents of parents	Entrance test scores
Asep	781	2	3	158
Aziz	755.9	1.5	4	150
Bine Lestrai	776.5	3	3	135
Cep S	681	4	5	134
Dhea Noer F	781	2	3	145
Didi Yusup	792	3	4	144
Dhita S	758	2.5	2	130
Eva Erviana	689	1.4	3	131
Gelar Widi P	700	1.5	4	145
Muhamad Saepul H	716	1.85	5	167
Nurali D	770	1.48	4	147
Rega Putra	774	2.25	3	156
Riski S	757	3.45	4	140
Suci Sugiyati	683	2.86	4	146
Tria Mega U	748	3.45	5	134

### 2.2 Analysis Data

The analysis method can be based on the results of the questionnaire about the determination of new student scholarship recipients based on the requirements determined by institutions and foundations using the fuzzy c-means logic method to determine the cluster or grouping criteria for prospective scholarship recipients. The basic concept of determining the cluster or grouping criteria for potential scholarship recipients with the fuzzy c-means clustering method. The basis of the first fuzzy c-means clustering is to determine the center of the cluster, which will mark the average location for each cluster. After the formation of a cluster of data processed by the fuzzy c-means clustering method, then the next step is to calculate the XB index for each cluster using Equation 1.

$$XB = \frac{\sum_{j=1}^c \sum_{i=1}^n [w_{ik}^w \times |V_i - X_j|^2]}{n \times \min_{i,j} |V_i - X_j|^2} \quad (1)$$

After getting the best cluster, the cluster members will do the weighing and ranking process using a simple additive weighting method. After the entire data processing is done, the next step is testing and analysis. Testing is done by comparing the results of recommendations from decision

support systems with decision-makers; the accuracy value is calculated using the accuracy formula in Equation 2.

$$Ac = \frac{T_N + T_P}{T_N + F_P + F_N + T_P} \quad (2)$$

Where: TN-Number of correct negative predictions, FP-Number of true positive predictions, FN-Number of negative predictions, TP-Number of positive positive predictions wrong.

## 3. RESULTS AND DISCUSSION

### 3.1 Clustering of Scholarship prospective recipients

The data in Table 1 is made into three clusters. Based on these data, the best alternative from the data will be used as recommendations for decision-makers. The calculation results show that in the 10th iteration, the following clusters are obtained (Table 2).

- [1] The first cluster, prospective scholarship recipients have a cumulative grade of high school report cards around 778.9; has a total parent income of around IDR 2,252,600; several dependents of family heads about three people; has a cumulative score for the entrance exam around 148.3.
- [2] The second cluster, prospective scholarship recipients have a cumulative grade of high school report cards around 690; has a total parent income of around IDR 2,409,200; the number of dependents of the family head is around four people; has a cumulative score for the entrance exam around 140.9.
- [3] The third cluster, prospective scholarship recipients have a cumulative grade of high school report cards around 754.4; has a total parent income of around Rp 2,798,900; several dependents of family heads around 3 to 4 people; has a cumulative score for the entrance exam around 138.9.

**Table 2. The results of the FCM cluster on the 10th iteration**

Data	Cluster membership degree			Clustering Results		
	1	2	3	1	2	3
Asep H	0.907	0.0103	0.0826	*		
Aziz M	0.1856	0.0225	0.7918			*
Bine Lestari	0.72	0.0177	0.2623	*		
Cep S	0.0131	0.9632	0.0237		*	
Dhea N	0.9778	0.0018	0.0202	*		
Didi Yusup	0.8697	0.0159	0.1145	*		
Dhita S	0.1092	0.0179	0.8729			*
Eva Erviana	0.0117	0.9657	0.0226		*	
Gelar Widi	0.0176	0.9456	0.0368		*	
Muhamad S	0.1641	0.5225	0.3134		*	
Nurali D	0.7809	0.0101	0.209	*		
Rega Putra	0.8811	0.0101	0.1087	*		
Riski Saputra	0.015	0.0019	0.9831			*
Suci Sugiyati	0.0081	0.9778	0.0144		*	
Tria Mega	0.0081	0.9775	0.0144		*	

### 3.2 Testing and analysis

The method used for system testers is to use the McCall method. The aim is to get good results from respondents. The number of respondents was eight people. From the research analysis, it can be concluded (Table 4) that the value obtained through a questionnaire regarding the decision support system for the recipient of the College of Technology Nusa Putra scholarship scored (72.56%) with a pretty good predicate. A more significant development is needed to perfect the system, improve quality to be very good.

**Table 3. Comparison of system accuracy testing results**

Name of Participant	Decision support system	Reviewer Recommendation
Asep Hermawan	Recommended	Not recommended
Aziz Mubaroq	Recommended	Not recommended
Bine Lestari	Recommended	Recommended
Cep Saepuloh	Not recommended	Not recommended
Dhea Nurfatimah	Recommended	Direkomendasikan
Didi Yusup	Recommended	Direkomendasikan
Dhita Sastianingsih	Recommended	Direkomendasikan
Eva Erviana	Not recommended	Not recommended
Gelar Widi Pramesti	Not recommended	Not recommended
Muhamad Saeful Hidayat	Not recommended	Not recommended
Nurali Daryana	Recommended	Recommended
Rega Putra Kurnia	Recommended	Recommended
Riski Saputra	Recommended	Recommended
Suci Sugiyati	Not recommended	Recommended
Tria Mega Utami	Not recommended	Recommended

### 3.3 User acceptance testing

The method used for system testers is to use the McCall method. The aim is to get good results from respondents. The number of respondents was eight people. From the research analysis, it can be concluded (Table 4) that the value obtained through a questionnaire regarding the decision support system for the recipient of the College of Technology Nusa Putra scholarship scored (72.56%) with a pretty good predicate. A more significant development is needed to perfect the system, improve quality to be very good.

**Table 4. Assessment of McCall's Testing Method**

No	Factor	Grade
1	Efficiency	6.73
2	Reliability	7.6
3	Maintainability	7.230
4	Usability	7.370
5	Compatibility	7.350

## CONCLUSION

The decision making of the College of Technology Nusa Putra scholarship recipient by applying the decision support system using the integration of the fuzzy c-means clustering method with the simple additive weighting method has been carried out. Determination of decision making for scholarship recipients with this decision support system is more objective than determining the choice of scholarship recipients manually and is more effective and efficient with an accuracy of 73.3%.

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