DECISION SUPPORT SYSTEM FOR SCHOLARSHIP IN BALI STATE POLYTECHNIC USING AHP AND TOPSIS

Ni Gusti Ayu Putu Harry Saptarini[1], Putu Manik Prihatini[2]
Informatics Department, Bali State Polytechnic[1,2],
Kampus Politeknik Negeri Bali
Bukit Jimbaran, Kuta Selatan, Badung Bali, PO BOX 1064 Tuban
Kode Pos 80364 Telp. (0361) 701981 Fax. (0361) [1,2]
ayu_harry@yahoo.com[1], manikprihatini@pnb.ac.id[2]

ABSTRACT

One effort to help people in continuing their education is through a scholarship program. Currently there are many scholarship programs from the government and state-owned enterprises or private. With the help of these educational, students race to achieve in order to offset the cost of education which is currently quite expensive. The number of students applying for the scholarship would require a separate time to filter out students who meet the requirements and then rank students based on the criteria of the scholarship. The complexity of the problems occur because each criterion has its own priority. Screening and grading manually would require considerable time and susceptible to human error. This research, developed automatic screening and decision support system to rank students according to given criteria. The method used is analytical hierarchycal process (AHP) to give weight to each criterion based on its priority, and the technique for order of preference by similarity to ideal solution (TOPSIS) to rank students based on its values of each criterion. By construct this decision support system, then selecting scholarship recipients can be faster and valid. The system that was built provide recommendations by rank students based on the final calculation.

KEY WORDS

Decision Support System, AHP, TOPSIS, Scholarship.

1. Introduction

Education is a very important thing. A good standard of living can be achieved by one of them with a good education. By having a higher education, the opportunity to obtain a better life will be higher as well. Today many students experiencing economic constraints in higher education. One way to alleviate the burden is by providing scholarships. Scholarships are usually awarded by certain agency or organization. Scholarships given can be varied as scholarships for poor students or achievements. This programs are expected to help students in education funding so that more people can take higher education.

Bali State Polytechnic (PNB) is one vocational education institutions located in Jimbaran Bali. On the academic year of 2013/2014, the number of students were 2990. In PNB there are many types of scholarships are offered. In last 3 years, there are between 10 to 11 types of scholarships are offered each year. Eachoffered scholarship has some assessment criteria for determining who is entitled to a scholarship student. The criteria used usually in the form of GPA, parents income, number of family members covered parents, academic and non-academic achievement (SKKM). Every applicant will be compared to get student with the highest score to receive scholarship.

The number of applicants for each scholarship at PNB, resulting in resource needs both time and human to do the

selection criteria by comparing one by one applicant.This problem becomes complex because the combination ofmany applicants and criteria used for selecting scholarship applicants.

Thus we need a decision support system (DSS) to assist decision making recipients in PNB. Using DSS, the time for decision-making can be more quickly and scholarship recipients are students who fit all criteria. This study using TOPSIS method for the decision-making process by comparing the valuesof each criterion of the applicants, while the weighting of each of the criteria used in the assessment usingtwo choices, inputting weights based on the preferences of decision makers or using AHP. AHP method is a method that is quite simple but good in the weighting and comparison of several criteria. TOPSIS method not only produces a decision that comes closest to the positive criteria, but at the same time also resulted in the decision by far the most negative criteria.

Some studies for decision making using AHP has been done by Tahriris et al[1] to assist decision making to supplierelection.Syamsuddin and Hwang [2] using AHP in its research to develop a decision support system for the banking industry related to security issues e-banking.Triantaphyllou and Mann [3] using AHP to assist decision-makers in the field of engineering.Wei et al. [4] using the AHP in building decision support system in the election of the Enterprise Resource Planning system (ERP).

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a method that is widely used in making a decision. There are several studies conducted by TOPSIS method as practiced by Jahanshahloo et al. [5] using TOPSIS method for building decision support system on problems with the data which the fuzzy, where fuzzy numbers normalized value is calculated using the concept of α-cuts.Ataei [6] using TOPSIS and fuzzy TOPSIS to build a decision support system for the design layout of the plant. Rahimi et al [7] to build a web-based decision support system for medical diagnosis with TOPSIS method. Athawale and Chakraborty [8] using TOPSIS to build a decision support system in evaluating the CNC machine of the specifications and costs.

Several studies have been done to build a decision support system for granting beasiswa.Wimatsari et al [9] using TOPSIS method for building decision support system with Fuzzy TOPSIS at the University Udayana.Wibowo et al [10] using Simple Additive weighting method (SAW) to build a support system Bank BRI grantee's decision at the Islamic University of Indonesia. In this study used AHP to compare the level of interest among the assessment criteria, which is a synthesis of the pairwise comparison matrix will be the weight for each criterion. By applying the method of AHP, is expected to better reflect the weight of each criterion which is formed between the level of importance of each criterion in which the weights will be used in the matrix calculation on TOPSIS method. By combining both methods is expected DSS built will be able to improve the process and quality of admission scholarship in PNB, so as to improve the effectiveness and efficiency of the decision making process.

2. Research Method

This research using AHP and TOPSIS to make a decision support system. AHP is used to gain weightof each criterion by compared their priority. TOPSIS then used to rank all of candidate. TOPSIS will give the best candidate who has the shortest distance with positive ideal solution and the longest distance to negative ideal solution.

2.1 Analytical Hierarchycal Process

Analytic Hierarchy Process (AHP) is a measurement theory through pairwise comparisons and rely on the judgment of experts to get the priority scale. AHP will buildthepairwise comparisonmatrix between a criterion with other criteria. Comparison matrix for decision variables on each criterion will also be built. Table 1 is a scale that is used for charging the pairwise comparison matrix in AHP

Table 1

Saaty Rating Scale for Pairwise Comparison Matrix[11]

Intensity of Importance	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective
3	Somewhat more importance	Experience and judgement slightly favour one over the other
5	Much more	Experience and judgement strongly favour one over the other
7	Very much more important	Experience and judgement very strongly favour one over the other
9	Absolutely more important	The evidence favouring one over the other is of the highest possible validity
2,4,6,8	Intermediate value	When compromise is needed

This is the step done in this research using AHP :

1. Build a pairwise comparison matrix for each of the criteria according to Table 1
2. Perform the synthesis of each alternative decision
3. Calculate the consistency index (C.I.)
4. Perform a comparison between criteria and alternatives
5. Calculate the final ranking

2.2 The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) is one method in decision-making which is in producing a decision will choose the alternative that is not only the most positive approach the ideal solution, but also the most distant from the negative ideal solution.

According Zahedy F. [12], with m criteria and n alternative, then the steps are performed in TOPSIS method is:

1. Build a normalized decision matrix.

   In TOPSIS, the performance of each alternative is calculated using Equation 1.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad (1)$$

2. Build a normalized weighting matrix

   The ideal positive and negative solution A- A + can be determined based on the normalized weight rating (yij) as follows:

$$y_{ij} = w_i r_{ij} (2)$$

$$dengan\ i = 1,2,\dots,m; dan\ j = 1,2,\dots,n$$

3. Determine the ideal solution both positive and negative

   Positive ideal solution matrix can be calculated with Equation 3, while the negative ideal solution matrix can be calculated by Equation 4

$$A^+ = (y_1^+, y_2^+, \dots, y_n^+); \qquad (3)$$

$$A^- = (y_1^-, y_2^-, \dots, y_n^-); \qquad (4)$$

4. Calculate the distance of each alternative decision of the positive and negative solutions idela

   The distance between the alternative Ai with a positive ideal solution can be calculated by Equation 5

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ - y_{ij}\right)^2}\,; i = 1,2,\dots,m \quad (5)$$

   The distance between the alternative Ai with negative ideal solution can be calculated with Equation 6

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_i^-\right)^2}\,; i = 1,2,\dots,m \quad (6)$$

5. Determining the value of the preference for each alternative

   Preference value for each alternative (Vi) is given by Equation 7.

$$V_i = \frac{D_i^-}{D_i^- + D_i^+}\,; i = 1,2,\dots,m \quad (7)$$

3. Result and Analysis

3.1 System Analysis and Design

The flowchart of decision support system built is shown in Figure 1.AHP is used to determining criteria weight based on its priority input by user in pairwise matrix. For every student, the fuzzification will be done and the result will be used to calculated the closeness value using TOPSIS.

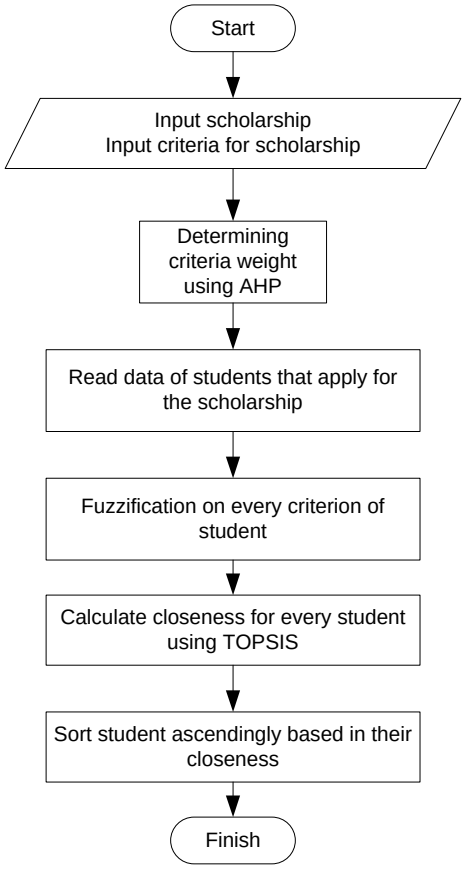

Figure 1. Flowchart of System

Context diagram (CD) for this system is shown in Figure 2, and data flow diagram (DFD) is shown in Figure 3

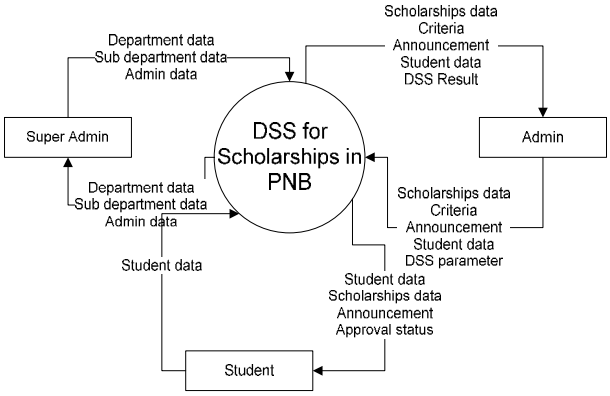

Figure 2. Context Diagram of System

Entity relationship diagram (ERD) for the system is shown in Figure 4. There are nine entities in the system. Every entities has their relationship to others.

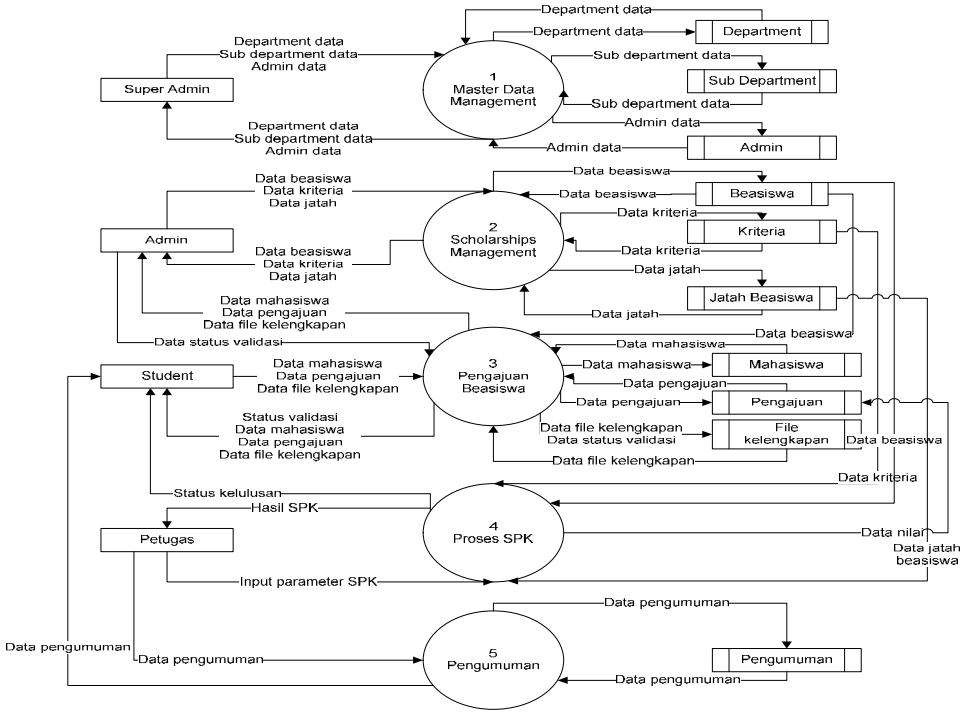

Figure 3. Data Flow Diagram of System

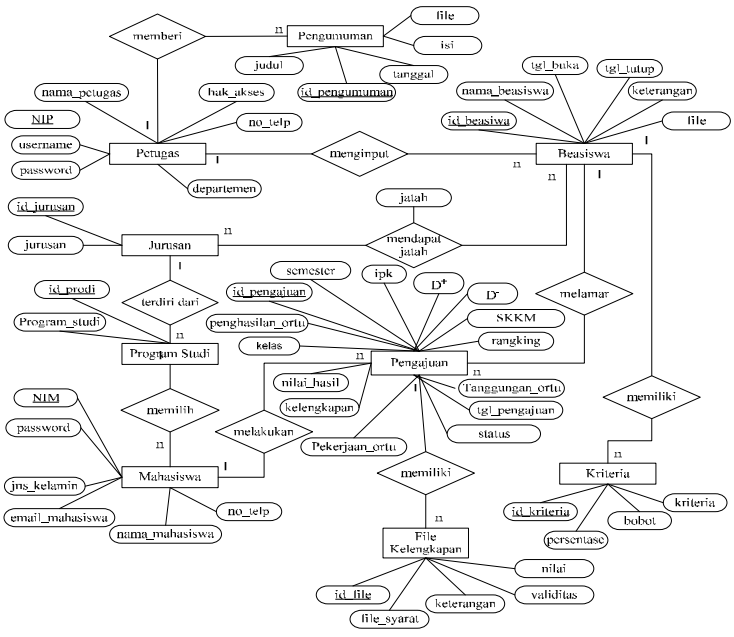

Figure 4. Entity Relationship Diagram of System

Fuzzy graph for GPA, economic condition (parents income/number of family members covered parents), academic and non-academic achievement (SKKM) is shown in Figure 5,6, and 7 respectively. There are five kinds of linguistic for each criterion.

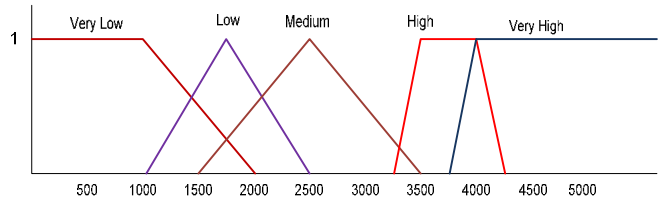

Figure 5. Fuzzy Graph of GPA

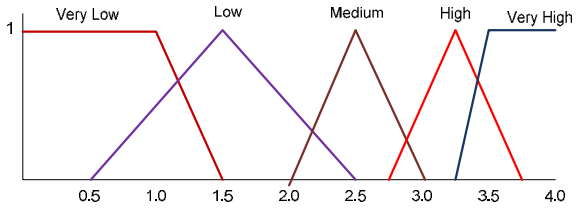

Figure 6. Fuzzy Graph of Economic

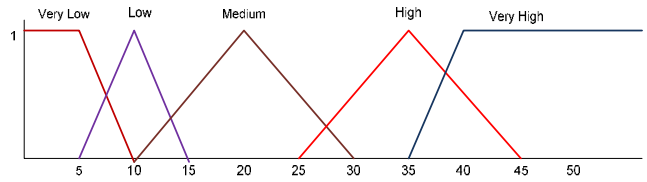

Figure7. Fuzzy Graph of SKKM

3.2 AHP Method

In this study, we use AHP to get the weight of each criterion based on their priority compared to others. User needs to input the priority in pairwise matrix. The value inputted to pairwise matrix based on Table 1. Figure 8 show example input for each criterion. User only input above the diagonal, while the rest will calculated automatically. The weight for Figure8 is shown in Figure 9, which is used for TOPSIS method as a weight for each criterion. In Figure 1, A is GPA, B is SKKM, and C for economic condition (parents income/number of family members covered parents).

	IPK	Penghasilan/ Tanggungan	SKKM
IPK	1	7	5
Penghasilan/Tanggungan		1	1/4
SKKM			1

Hitung Bobot

Figure 8. Inputted Priority in Pairwise Matrix

A	B	C
0.71	0.08	0.21

Figure 9. The weight for each criterion resulted by AHP

3.3 TOPSIS Method

This study use 25 student data as experiment to test TOPSIS method. Figure 10 shows data of 25 students use to held the experiment. Linguistic is gotten from fuzzy graph in Figure 5,6 and 7. Data in Figure 10 is normalized using Equation 1, and then the weighted normalized matrix is calculated using Equation 2. In this case we use 3 criterion, which is GPA and SKKM as positive criteria and economic condition as negative criteria. The positive ideal solution for positive criteria isthe maximum weighted of all students in that criterion, while for negative criteria isthe minimum weighted of all students. On the contrary, the negative ideal solution for positive criteria isthe minimum weighted of all students, while for negative criteria isthe maximum weighted of all students. The positive and negative ideal solution is shown in Figure 11. $Y_1$is for GPA, y_2 for SKKM, and $y_3$for economic condition. The next step is calculating the distance for solution ideal positive and negative using Equation 5 and 6 respectively. The last step for TOPSIS is calculating closeness value using Equation 7. Closeness is a measurement that guaranteed the candidate to close to positive ideal solution and far from the negative ideal solution. The TOPSIS result is shown in Figure 12, where those data is sorted descending based on closeness value.

No.	NIM	Name	Grade	Major	GPA	Linguistic	SKKM	Linguistic	Parent Salary	Family Number	Economic Condition	Linguistic
1	1415323003	ADI BAGUS SURYADANA	4	Teknik Elektro	2.71	Medium	2	VL	2,313,000	10	231,300	VL
2	1415323004	I PUTU SUGITA WIGUNA	2	Teknik Elektro	3.3	High	54	VH	4,650,000	6	775,000	VL
3	1415323006	I WAYAN PANJI PALGUNA	2	Teknik Elektro	3.13	High	29	High	9,735,000	10	973,500	VL
4	1415323009	IDA BAGUS BUDI HARTA	4	Teknik Elektro	3.03	High	66	VH	3,992,000	2	1,996,000	Low
5	1415323012	I WAYAN AGUS WIDNYANA	2	Teknik Elektro	3.3	High	56	VH	6,112,000	4	1,528,000	Low
6	1415323024	PUTU DONI WIRAWAN	2	Teknik Elektro	3.91	VH	69	VH	8,341,000	4	2,085,250	Medium
7	1415323027	I PUTU MEIKA MAHARDIKA	2	Teknik Elektro	2.62	Medium	65	VH	8,922,000	6	1,487,000	Low
8	1415323031	DEKA SAND OKKY	2	Teknik Elektro	2.35	Medium	44	VH	3,852,000	8	481,500	VL
9	1415323032	I WAYAN AMLA APRIANA	2	Teknik Elektro	3.92	VH	38	High	910,000	5	182,000	VL
10	1415323040	RIZKY RIZALDI	2	Teknik Elektro	3.49	VH	45	VH	9,639,000	4	2,409,750	Medium
11	1415323037	KADEK JON SUDARMAWAN	4	Teknik Elektro	2.98	High	28	High	3,712,000	8	464,000	VL
12	1415323044	SARASWATI SUCI CAHYATI	2	Teknik Elektro	2.62	Medium	54	VH	8,889,000	8	1,111,125	Low
13	1415323045	DICKYU BELLINA	2	Teknik Elektro	2	Low	17	Medium	8,976,000	5	1,795,200	Low
14	1415323081	I GUSTI NGURAH ADITHYA	2	Teknik Elektro	2.74	Medium	55	VH	3,496,000	7	499,429	VL
15	1415323047	I WAYAN TISNA ADI	4	Teknik Elektro	3.14	High	59	VH	4,494,000	10	449,400	VL
16	1415323052	NURUL AIDA	4	Teknik Elektro	2.02	Low	28	High	2,180,000	10	218,000	VL
17	1415323055	DWI FITRI FATMAWATI	4	Teknik Mesin	3.99	VH	65	VH	9,824,000	3	3,274,667	High
18	1415323060	DEWA GEDE ADI PUTRA	4	Teknik Mesin	3.35	High	27	Medium	8,616,000	5	1,723,200	Low
19	1415323064	RAHMAT SUJIANTO	2	Teknik Mesin	3.06	High	17	Medium	7,411,000	10	741,100	VL
20	1415323066	JACKY AKBAR SAPUTRA	4	Teknik Mesin	3.76	VH	34	High	9,555,000	7	1,365,000	Low
21	1415323068	MADE CHANDRA BUDIAWAN	2	Teknik Mesin	3.32	High	40	VH	6,719,000	9	746,556	VL
22	1415323071	ADITHYA PUTRA UTOMO	2	Teknik Mesin	2	Low	32	High	951,000	6	158,500	VL
23	1415323074	I GUSTI NGURAH MADE BUDI	4	Teknik Mesin	3.66	VH	44	VH	3,852,000	8	481,500	VL
24	1415323080	I WAYAN NOVA KUSADI	4	Teknik Mesin	2	Low	2	VL	4,590,000	7	655,714	VL
25	1415323084	I GUST BAGUS NGURAH	2	Teknik Mesin	2.41	Medium	12	Low	7,679,000	5	1,535,800	Low

Keterangan VL :Very Low

VH : Very High

Figure 10. Data Testing and Fuzzy Linguistic for Every Student

	y1	y2	y3
A+	0.20	0.16	0.01
A-	0.04	0.01	0.16

Figure 11. Ideal Positive and Negative Solution for Each Criterion

Ranking	NIM	Nama	D+	D-	Closeness
1	1415323074	ADI BAGUS SURYADANA PRAKOSO	0.1090	0.2211	0.6699
2	1415323040	I PUTU SUGITA WIGUNA	0.1104	0.2095	0.6548
3	1415323024	I WAYAN PANJI PALGUNA	0.1104	0.2095	0.6548
4	1415323032	IDA BAGUS BUDI HARTA GUNA	0.1188	0.2196	0.6488
5	1415323055	I WAYAN AGUS WIDNYANA	0.1122	0.2040	0.6450
6	1415323066	PUTU DONI WIRAWAN	0.1192	0.2136	0.6419
7	1415323047	I PUTU MEIKA MAHARDIKA	0.1159	0.1948	0.6269
8	1415323068	DEKA SAND OKKY	0.1159	0.1948	0.6269
9	1415323004	I WAYAN AMLA APRIANA	0.1159	0.1948	0.6269
10	1415323009	RIZKY RIZALDI	0.1163	0.1880	0.6178
11	1415323012	KADEK JON SUDARMAWAN	0.1163	0.1880	0.6178
12	1415323037	SARASWATI SUCI CAHYATI	0.1253	0.1930	0.6065
13	1415323006	DICKYU BELLINA	0.1253	0.1930	0.6065
14	1415323064	I GUSTI NGURAH ADITHYA DWIANTO	0.1346	0.1918	0.5875
15	1415323060	I WAYAN TISNA ADI MULIARTA	0.1349	0.1849	0.5781
16	1415323081	NURUL AIDA	0.1611	0.1594	0.4973
17	1415323031	DWI FITRI FATMAWATI	0.1611	0.1594	0.4973
18	1415323027	DEWA GEDE ADI PUTRA SWASTIKA	0.1614	0.1511	0.4835
19	1415323044	RAHMAT SUJIANTO	0.1614	0.1511	0.4835
20	1415323003	JACKY AKBAR SAPUTRA	0.1900	0.1545	0.4484
21	1415323084	MADE CHANDRA BUDIAWAN	0.1827	0.1462	0.4445
22	1415323052	ADITHYA PUTRA UTOMO	0.1979	0.1522	0.4347
23	1415323071	I GUSTI NGURAH MADE BUDI WISNAMA	0.1979	0.1522	0.4347
24	1415323045	I WAYAN NOVA KUSADI	0.2042	0.1418	0.4098
25	1415323080	I GUST BAGUS NGURAH DHARMA PUTRA	0.2170	0.1493	0.4077

Figure 12. TOPSIS Result Ordered By Closeness in Descending Order

The student who has the highest closeness value is the first priority to get scholarships based on TOPSIS method.

4. Conclusion

It can be conclude that applying AHP and TOPSIS for scholarships program selection can be done. Structured system design is modeled by context diagram and data flow diagram. The database design is model by entity relationship diagram. AHP can be applied to determine the weight of each criterion through pairwise matrix. Those weight then use in TOPSIS method. Fuzzy is used to represent linguistic for every student. TOPSIS method give a value of closeness for every student, that value represent both distance, to negative and positive ideal solution. The final result of the DSS is the rank of student based on their closeness value. The best closeness value is the first priority to get scholarship.

References

[1] Tahriri, F, Osman, M. R., Ali A., Yusuff R. M., Esfandiary A., 2008. AHP Approach for Supplier Evaluation and Selection in a SteelManufacturing Company. Journal of Industrial Engineering and Management 01(02).hal. 54-76

[2]Syamsuddin I., Hwang J., 2009,The Application of AHP Model to Guide Decision Makers: A Case Study of E-Banking Security. Fourth International Conference on Computer Sciences and Convergence Information Technology

[3]Triantaphyllou E., Mann, S. H., 1995. Using the Analytic Hierarchy Process for Decision Making in Engineering Applications: Some Challenges. Inter'l Journal of Industrial Engineering: Applications and Practice, Vol. 2, No. 1, hal. 35-44

[4]Wei CC., Chien C., WangMJ., 2005,An AHP-Based Approach to ERP System Selection. Int. J. Production Economics 96 (2005) hal.47–62

[5]JahanshahlooG.R., Lotfi F. H., Izadikhah M., 2006,Extension of The TOPSIS Method for Decision-MakingProblems With Fuzzy Data. Applied Mathematics and Computation 181 (2006) hal.1544–1551

[6] Ataei E., 2013,Application of TOPSIS and Fuzzy TOPSIS Methods for Plant Layout Design. World Applied Sciences Journal 24 (7),hal. 908-913

[7] Rahimi S.,Gandy L.,Mogharreban N., 2007,A Web-Based High-PerformanceMulticriteria Decision Support Systemfor Medical Diagnosis.International Journal of Intelligent Systems, Vol. 22, hal.1083–1099

[8] Athawale V. M., Chakraborty S., 2010,A TOPSIS Method-based Approach to Machine Tool Selection. Proceedings of the 2010 International Conference on Industrial Engineering and Operations ManagementDhaka, Bangladesh, January 9 – 10, 2010

[9] Wimatsari G. A. M. S, Putra I. K. G. D., Buana P. W., 2013,Multi-Attribute Decision Making Scholarship Selection Using a Modified Fuzzy TOPSIS. IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 1, No 2, January 2013

[10] Wibowo H.S., Amalia R., Fadlun M. A, Arivanty K., 2009,Sistem Pendukung Keputusan untuk Menentukan PenerimaBeasiswa Bank BRI Menggunakan FMADM (Studi Kasus: Mahasiswa Fakultas Teknologi IndustriUniversitas Islam Indonesia). Seminar Nasional Aplikasi Teknologi Informasi 2009 (SNATI 2009) ISSN: 1907-5022, Yogyakarta, 20 Juni 2009

[11] Saaty, T. L., 2008,Decision Making With the Analytic Hierarchy Process. Int. J. Services Sciences, Vol. 1, No. 1

[12] F. Zahedi, 1977, The Analytic Hierarchy Process-A Survey Of The Method and Its Applications, Interfaces, Vol. 16, hal.343-350