Bulletin of Electrical Engineering and Informatics
Vol. 13, No. 3, June 2024, pp. 2048~2057
ISSN: 2302-9285, DOI: 10.11591/eei.v13i3.7038

The model of decision support system using hybrid method and actual weighting for the study program ranking

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Article Info

Article history:

Received Jun 20, 2023
Revised Oct 4, 2023
Accepted Oct 24, 2023

Keywords:

Actual weight
Analytical hierarchy process
Decision support system
Hybrid method
Simple additive weighting

ABSTRACT

Nowadays the good or bad study program can be seen from the accreditation rank that it obtains from the institution of college accreditation. However, it is frequently found at college that there are some study programs that have the same accreditation. This encourages the college to do another approach which can do this study program ranking from a different point of view. This research developed a model of decision support system to do ranking towards 25 study programs existed in the environment of Sriwijaya State Polytechnic. Hybrid method employed the combination of analytical hierarchy process (AHP) and simple additive weighting (SAW) to do the ranking. Actual weighting model was used in the calculation based on the fact obtained in each study program, and in line with the criteria which had been determined. As many as 7 relevant criteria and 21 sub criteria were used in this model. The results of this research showed that the model which had been developed can give recommendation in the form of study program ranking with actual condition based on the data attached to each study program.

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1. INTRODUCTION

College has the role to improve human resources ability [1], empower individual [2], and generate educated labors [3]. Higher education is also demanded to generate human resources that have intelligence level, creativity, and character [4]. The success of an education program is a concept of education equality which aims to educate the life of a nation [5]. The learning process in college is a systmatic, directed, and complex activity in accordance with the curriculum which it selected [6]. The relevance between colleges and stakeholders are the relationship which needs to be maintained in order to improve the quality of education process. Until, the study program existed in college is the important part in producing the graduates who can fulfill the demand of the work world, business world, and industry world [7].

Decision support system (DSS) has a very important role to facilitate the management and daily operational at college [8]. Even [9] mentioned that DSS is an important tool which can help the management at college in the process of taking decision and strategic management. According to Alshadoodee *et al.* [10], internal and external data of an organization can be used in DSS development. Beside that, the data used to build DSS can also come from various domains [11] and various types of data [12]. One of important cases revealed by [13] was in DSS implementation at college to solve the problem of students' resignation before graduation. One of the causes was the curriculum that the students wanted to learn was not in line with their talent and interest. DSS is a part of computer software based information system [14], which consisted of

knowledge management based system that usually in mathematics model [15], and can be used to support decision taking in certain organization or company [16].

The combination of some models used in DSS development is known as hybrid approach [17]. This hybrid approach utilized the strength of various models, method, and algorithm to give the more accurate and accountable decision [18]. The approach using analytical hierarchy process (AHP) is to find the criteria weight and simple additive weighting (SAW) is to do ranking have been carried out by [19] to do the selection of excellent mango seeds. In this research, 5 criteria were used in selecting 10 alternatives. This research has successfully generated the recommendation in the form of alternative best ranking from the excellent mango seeds. AHP and SMART method are also used as hybrid approach in determining the superior cow [20]. As many as 8 criteria were used in selecting 15 alternatives. This research can give recommendation of the best superior cow with highest score from the model which had been developed. Another hybrid model was also developed in [21] which used rule-based reasoning (RBR) and fuzzy logic classifier (FLC) to predict triage level for the patient in Emergency Installation Unit. This research could decrease the mistake level in patient's diagnostic, and had accuracy level amounted 99.44%. Hybrid method used AHP and technique of order performance by similarity to ideal solution (TOPSIS) approach also had been used in loan approval [22]. This research employed 5 criteria and 5 alternatives in a model test. This research obtained ratio consistency value leass than 0.10. Further, this research suggested the model trial using fuzzy mutiple attribute decision making (FMADM) for the similar case.

The research conducted by Wahyuni and Wayahdi [23], has developed the model to do the private college ranking in Medan city. The method used was AHP, with 4 criteria that were considered namely competent lecturer, study program accreditation, health, and grant or scholarships. AHP was also used by [24] to select college for prospective students coming from senior high school in Kuwait. As many as 7 criteria were considered namely education level, university lifestyle, job opportunity, university reputation, transportation, family reason, and friends or relationship reasons. This research had generated the relevant college recommendation with various criteria which had been determined. AHP method was also used to do a selection of Maahad Tahfidz Center which in the research [25] used the test to select 4 alternatives. The criteria used in the model were academic, facilities, cost, and location. However, this research did not specifically yet show the calculation result from the model being developed. AHP and SAW method had also been used in determining the hal culinary recommendation for tourisms in North Sumatera area [26]. This research employed 9 criteria and alternatives. This research had successfully did ranking on the alternatives developed in the model.

The research done by Tamsir and Alam [27] has developed DSS model for selecting the major which is suitable with the skill, ability, interest, and talent of students until it influences the students' success. The model used was Naive Bayes and the method of data collection used observation and direct interview. The criteria that were considered were the interest in natural sciences, the interest in social sciences, and the language interest. This model had successfully assisted the selection of the major which is suitable with the potential owned. The research related to the selection of study program concentration also had been conducted by [28]. This research employed the combination of AHP model to test the consistency and TOPSIS to choose the alternative based on the shortest distance. Some criteria considered were intelligence score, grade point average (GPA), course score, and TOEFL score. This research generated the accuracy level amounted 67.00%.

The good or bad of study program existed in college can be seen from the accreditation level obtained by that study program. However, it is found that some study programs have the same accreditation level. Therefore, the college needs to have another alternative in seeing the rank of study program by looking at some criteria which could be considered. This research employed hybrid method to build a decision support system which can assist the college management in determining the rank of study program.

2. METHOD

This research followed the stages as can be seen in Figure 1. AHP method was a quite effective method to solve a complex problem. According to [29], [30], the stages in AHP covered; i) hierarchy, ii) the number of pairwise comparison, iii) consistency, iv) collaborative voting, and v) sensitivity analysis. As the weighting model in this research used actual weighting by detailing the criteria which had been determined to be sub criteria and actual weight which had been determined. Weight is a value of a criteria indicator [31] and according to [32] there are some weighting models in the decision support system namely percentage approach, fuzzy logic approach, and actual value approach. This actual value approach has the score range from 0 until 10 or from 0 until 100 with normalization $\sum Wj = 100\%$. This weighting model can map the subjective weighting model which in general the weighting determination was based on preference or the assessment of decision maker [33].

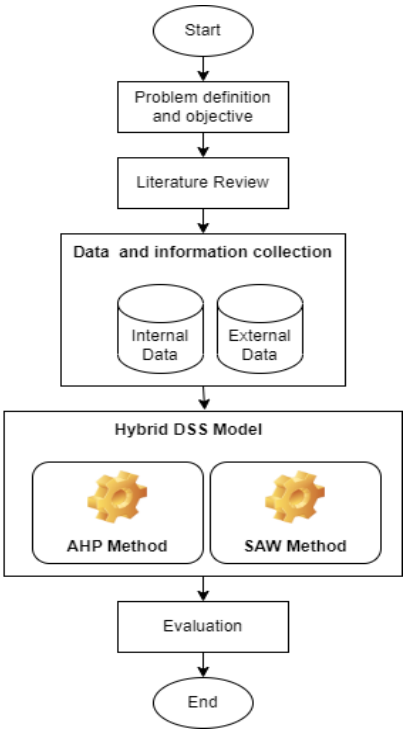

Figure 1. The research stages

2.1. The stage of problem definition and objective

In this stage there is a phenomenon where the college management wants to see the good or bad of study programs existed in college. This far the accreditation status was the main indicator in determining the good or bad of a study program. However, it is found that there are some study programs with the same accreditation level. Therefore, this research tried to make a ranking model of study program by using actual data and information owned by each study program.

2.2. The stage of literature review

This research carried out the adequate library study sourced from scientific journal, proceeding, and the books that were relevant to the research topic. The review of method and approach were conducted to gain the relevant method. The related research was also studied in this stage to gain important information which support the research.

2.3. Stage of data and information collection

After the literature review stage was sufficient, then the next stage was the collection of data and information. The data and information were obtained from internal and external source of the college. The data like accreditation status, the lecturer's education level, the lecturer's functional position, and the lecturer's certification were obtained from the internal college. While the data such as scientific publication was obtained from the research databases such as Google Scholar, Scopus, and Web of Science. While the ratio of lecturer and students was obtained from the database of higher education which contain the information of lecturer and students ratio for each study program.

2.4. The stage of hybrid DSS model

This DSS model which is being developed uses hybrid approach by combining the strength of AHP method and SAW method. Some stages were carried out in the calculation using hybrid method namely:

- Stage 1, defining the criteria and alternative. This stage is for determining a number of criteria and alternative that will be used as the indicator of problem solving and determining the importance level of each criteria.
- Stage 2, calculating the pairwise comparison matrix. In this stage was conducted the process of counting the pairwise comparison matrix value of each criteria based on the table of importance level (Table Saaty) like can be seen in Table 1.

Table 1. Scales for pairwise comparisons

Scale	Definition	The meaning
1	Equal importance	Two elements are equally important
3	Moderate importance	One element is slightly more important over another
5	Strong importance	One element is strongly more important over another
7	Very strong importance	One element is very strongly more important over another
9	Extreme importance	One element is extremely more important over another
2,4,6,8		The intermediate values

- Stage 3, determining the synthesis of priority. In this stage the pair matrix will be added up in each element and then the matrix will be normalized until it can count the weight of priority and existed criteria (Wi) by using (1):

$$W_i = \frac{1}{n} \sum_j a'_{ij} \quad (1)$$

- Stage 4, determining the value of logical consistency and finding the value of consistency index (CI). In this stage conducted the process of finding max Eigen value (λ Max) by multiplying the value in pair matrix with the priority value. This stage was carried out by using (2):

$$CI = \frac{\lambda max - n}{n-1} \quad (2)$$

- Stage 5, counting consistency ratio (CR). In this stage, if obtained CR value <0.1, then the data can be accepted and consistent.
- Stage 6, counting the value of preference weight (Vi) using (3):

$$V_i = \sum_{j=1}^{n} W_j X_{ij} \quad (3)$$

- Stage 7, carrying out ranking.

2.5. The stage of evaluation

After the ranking result from DSS model which had been developed is done, then the next stage was conducting evaluation. In this stage, evaluation was carried out to see if the calculation result of the model which had been developed was in line with the purpose which had been determined. Evaluation also ensures that the model is reliable enough to solve the existing cases.

3. RESULTS AND DISCUSSION

This research conducted the ranking of study programs existed in the environment of Sriwijaya State Polytechnic. As many as 7 criteria, 21 sub criteria, and 25 study programs consisted of D3, D4, and S2 (master degree) were used in the developed model. The data used in this study came from internal and external study programs.

3.1. Defining the criteria and alternative

Table 2 is the criteria that were considered in this model, consists of 7 criteria in determining the ranking of study programs. Table 3 was the actual weight used in sub criteria in determining the weight of each study program. This actual value is the result of the performance of each study program.

Table 2. The criteria of study program ranking

Criteria	Description
C1	The rank of study program accreditation
C2	The lecturer's education qualification
C3	The lecturer's functional position
C4	The lecturer's certification
C5	The productivity of lecturer's publication
C6	The students' achievement
C7	The ratio of lecturer and students

Table 3. The sub criteria of study program ranking

Criteria	Criteria	Sub–criteria	Actual weight
C1	The rank of study program accreditation	Accreditation A/superior	4.00
		Accreditation B/excellent	3.00
		Accreditation C/good	2.00
		Not accredited	1.00
C2	The lecturer's education qualification	Doctoral (S3)	0.70
		Master (S2)	0.30
C3	The lecturer's functional position	Professor	0.40
		Associate Professor	0.30
		Senior lecturer	0.20
		Assistant Professor	0.10
		Lecturer	0.00
C4	The lecturer's certification	Number of certified lecturers	0.80
		Number of non certified lecturer's yet	0.20
C5	The productivity of lecturer's publication	Indexed publication in Scopus	0.40
		Indexed publication in WoS	0.40
		Indexed publication in Google Scholar	0.20
C6	The students' achievement	Students' achievement in International level	0.40
		Students' achievement in National Scope	0.30
		Students' achievement in Regional Scope	0.20
		Students' achievement in Local Scope	0.10
C7	The ratio of lecturer and students	The ratio of lecturer and students	1.00

Figure 2 showed the hierarchy used in the model of AHP. In level 1 was the purpose of the model, namely conducting the ranking of the study program. In level 2 was determined some attributes as criteria. Furthermore, in level 3 was the sub criteria which will influence the alternative that will be processed further.

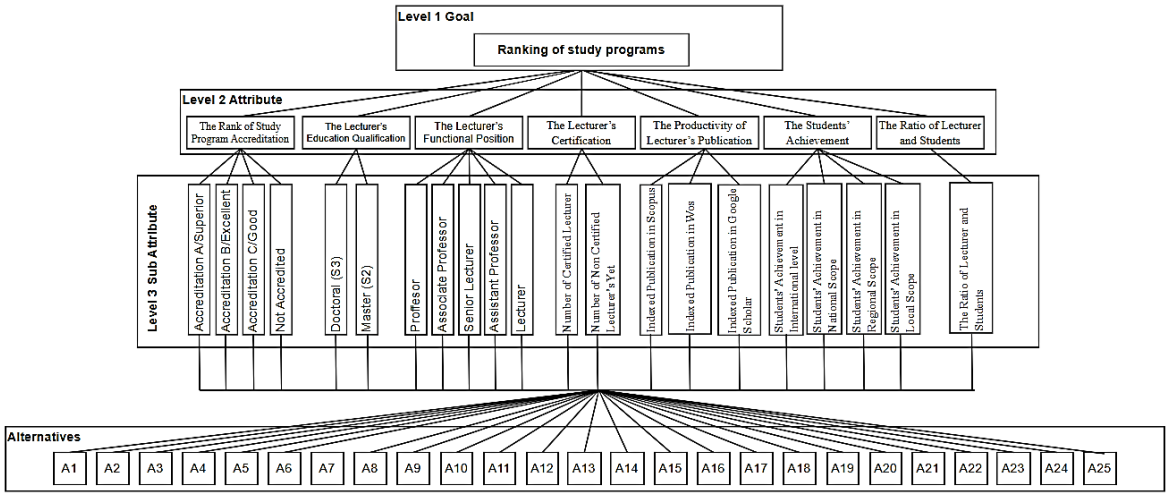

Figure 2. The hierarchy of hybrid DSS model

Table 4 is the preferences value from each study program based on the determined criteria. These data were the informations obtained from the internal and external of college. Therefore, the study program ranking can be obtained objectively based on those data and information.

3.2. Calculating the pairwise comparison matrix

In this stage, comparison was carried out based on "judgement" of decision maker by considering the level of importance among each criteria referring to Table 1. The result of pairwise comparison matrix can be seen in Table 5. Furthermore Table 6 is the normalization result from Table 5. In this normalization also conducted addition of each criteria. In C1 obtained the result 2.60, C2, C3, and C4 amounted 17.00, and the score amounted 7.00 for criteria C5, C6, and C7. The next stage was carrying out the synthesis of priority, after succeeding in gaining the result of addition in each criteria.

Table 4. Assessment data of alternative and criteria

Alternative	C1	C2	C3	C4	C5	C6	C7
A1	4	9.00	2.70	20.40	58.00	1.20	14.63
A2	4	7.40	4.60	14.96	202.00	2.50	13.30
A3	4	13.40	5.70	25.84	37.00	2.10	11.90
A4	3	6.60	2.80	14.96	25.60	1.30	14.41
A5	4	6.40	4.00	13.60	100.20	2.10	14.89
A6	4	5.20	3.00	10.88	64.20	0.90	9.33
A7	3	5.20	2.40	10.88	55.80	0.90	17.45
A8	3	7.50	4.70	17.00	19.80	2.20	13.34
A9	3	11.20	7.80	24.48	79.40	1.70	19.72
A10	3	11.10	2.50	25.16	82.80	1.10	12.30
A11	3	5.40	3.90	12.24	69.60	1.60	19.05
A12	1	3.60	0.20	8.16	10.00	0.10	0.00
A13	4	6.00	2.90	10.88	65.00	3.10	12.93
A14	4	7.00	3.00	9.52	60.00	1.10	0.00
A15	3	7.00	2.50	14.96	60.00	1.50	12.15
A16	3	8.30	5.80	17.00	27.00	1.20	14.00
A17	3	3.50	1.80	6.12	135.80	0.70	8.36
A18	3	5.20	3.10	10.88	85.60	1.10	14.30
A19	3	4.30	2.00	8.84	63.20	0.70	15.35
A20	3	2.80	1.70	5.44	201.80	2.40	13.37
A21	3	3.30	2.20	7.48	43.40	2.00	11.70
A22	3	4.00	2.40	8.16	65.80	1.30	10.79
A23	1	2.10	0.00	4.76	2.80	0.20	3.43
A24	3	5.60	2.70	8.16	59.20	1.10	0.00
A25	3	4.20	1.70	4.08	158.40	1.00	3.10

Table 5. The pairwise comparison matrix

Criteria	C1	C2	C3	C4	C5	C6	C7
C1	1	5/1	5/1	5/1	3/1	3/1	3/1
C2	1/5	1	1	1	1/3	1/3	1/3
C3	1/5	1	1	1	1/3	1/3	1/3
C4	1/5	1	1	1	1/3	1/3	1/3
C5	1/3	3/1	3/1	3/1	1	1	1
C6	1/3	3/1	3/1	3/1	1	1	1
C7	1/3	3/1	3/1	3/1	1	1	1

Table 6. The normalization of pairwise comparison matrix

Criteria	C1	C2	C3	C4	C5	C6	C7
C1	1	5	5	5	3	3	3
C2	0.20	1	1	1	0.33	0.33	0.33
C3	0.20	1	1	1	0.33	0.33	0.33
C4	0.20	1	1	1	0.33	0.33	0.33
C5	0.33	3	3	3	1	1	1
C6	0.33	3	3	3	1	1	1
C7	0.33	3	3	3	1	1	1
Total	2.60	17.00	17.00	17.00	7.00	7.00	7.00

3.3. Determining synthesis of priority

By using (1) then will be obtained the result as in Table 7. Then the following is the average value of pair comparison matrix from each criteria. The column value in Table 8 is summed, then divided with the total column amounted 7 columns. Until obtained the matrix with addition of priority column as in Table 8. Then the value of criteria weight (Wj)=(0.3647; 0.0564; 0.0564; 0.0564; 0.1550; 0.1550; 0.1550).

Table 7. The pairwise comparison matrix with summed criteria value

Criteria	C1	C2	C3	C4	C5	C6	C7
C1	1/2.60	5/17	5/17	5/17	3/7	3/7	3/7
C2	0.2/2.60	1/17	1/17	1/17	0.33/7	0.33/7	0.33/7
C3	0.2/2.60	1/17	1/17	1/17	0.33/7	0.33/7	0.33/7
C4	0.2/2.60	1/17	1/17	1/17	0.33/7	0.33/7	0.33/7
C5	0.33/2.60	3/17	3/17	3/17	1/7	1/7	1/7
C6	0.33/2.60	3/17	3/17	3/17	1/7	1/7	1/7
C7	0.33/2.60	3/17	3/17	3/17	1/7	1/7	1/7
Total	2.60	17.00	17.00	17.00	7.00	7.00	7.00

Table 8. The criteria of priority value

Criteria	C1	C2	C3	C4	C5	C6	C7	Priority
C1	0.3846	0.2941	0.2941	0.2941	0.4286	0.4286	0.4286	0.3647
C2	0.0769	0.0588	0.0588	0.0588	0.0471	0.0471	0.0471	0.0564
C3	0.0769	0.0588	0.0588	0.0588	0.0471	0.0471	0.0471	0.0564
C4	0.0769	0.0588	0.0588	0.0588	0.0471	0.0471	0.0471	0.0564
C5	0.1269	0.1765	0.1765	0.1765	0.1429	0.1429	0.1429	0.1550
C6	0.1269	0.1765	0.1765	0.1765	0.1429	0.1429	0.1429	0.1550
C7	0.1269	0.1765	0.1765	0.1765	0.1429	0.1429	0.1429	0.1550

3.4. Determining the value of logical consistency and the value of CI

The next stage was finding the value of max Eigen value (λ Max) by multiplying the value in the pair matrix with the priority value. Then obtained the value of $\lambda\, Max = 7.0638$. This value is then will be used to determine the value of CI. Matrix with 7 orders (namely consisted of 7 main criteria) were used in this research. Then to obtain CI gained as follows:

$$CI = \frac{\lambda max\ - n}{n-1}$$
$$= \frac{7.0638 - 7}{6}$$
$$= 0.0106$$

3.5. Finding the value of CR

For n=7, obtained random index (RI) with value 7 is 1.32, until CI/RI=0.0106/1.32=0.0080 which means 0.0080≤0.1 means the value is consistent. Value of CR is the result of a comparison between the consistency index (CI) and the RI. If CR≤0.10 (10%) it means that the user's answers are consistent so that the resulting solution is optimal.

3.6. Calculating the value of preference weight

The next stage was counting the value of preference weight using (3). The value of X is the matrix obtained from Table 4. Data assessment of alternative and criteria which were the actual weight of each study program based on the criteria that had been determined. The usage of this actual weight did not need the matrix normalization stage which considered the aspect of benefit and cost. Until this weight value will directly be counted to gain the value of preference weight. Table 9 is the result of calculations using (3). This table provides information on the weight of the final calculation results of each alternative.

Table 9. Rank each alternative

Alternatives	Weight
A1	14.71
A2	36.74
A3	11.90
A4	8.87
A5	20.98
A6	14.07
A7	13.63
A8	8.22
A9	19.17
A10	18.19
A11	16.30
A12	2.60
A13	15.13
A14	12.03
A15	13.89
A16	9.39
A17	24.19
A18	17.83
A19	14.23
A20	35.38
A21	10.68
A22	13.99
A23	1.75
A24	11.37
A25	26.84

3.7. Carrying out the ranking

Ranking is obtained by sorting the value of the biggest weight until the smallest weight. The biggest weight showed the highest rank. Likewise, the smallest value is the lowest rank. Based in Table 9, that gives the ranking information of the best study program, where alternative A2 is the best study program, followed by A20 and A25. The values resulted from the model showed that A2 obtained the value amounted 36.74, A20 amounted 35.38, and A25 amounted 26.84. While the lowest result obtained by alternative A23 amounted 1.75. After conducting the analysis on the alternative with the lowest rank, then the fact was obtained that the study program was a new study program until the activity of it is still few until the indicator of the study program performance was low.

3.8. Model evaluation

At this stage an evaluation is carried out to determine the performance of the model that has been developed. Testing is carried out by looking at recommendations resulting from manual calculations and results obtained from calculations from the application. Figure 3 shows the testing model implemented in a web-based application. Meanwhile, Table 10 shows a comparison of calculation results using manual calculations and using calculations produced by web-based applications. This shows the model that has been developed can be relied upon to be used in ranking study programs using several predetermined criteria.

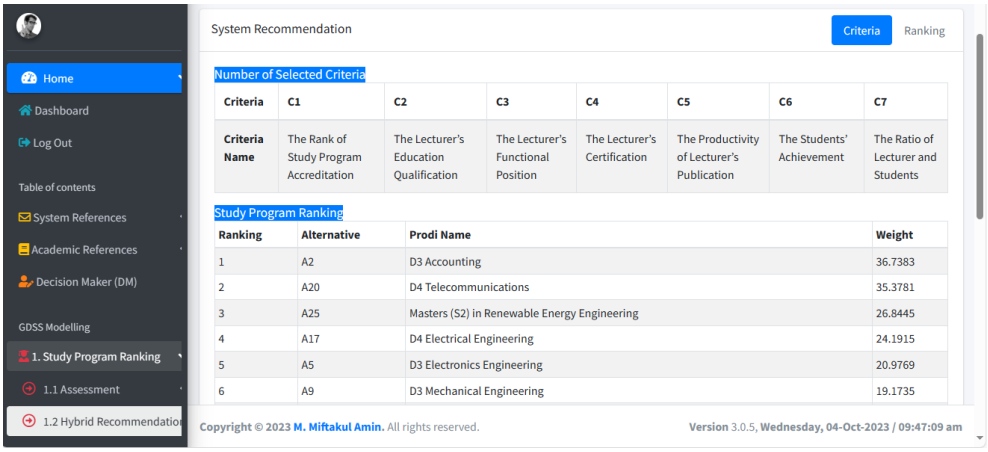

Figure 3. The result of alternatives ranking based on system

Table 10. The comparison of recommendation results

Alternatives	Manual calculation		System calculation		Conclusion
	Weight	Ranking	Weight	Ranking	
A1	14.71	11	14.7129	11	Valid
A2	36.74	1	36.7383	1	Valid
A3	11.90	18	11.8984	18	Valid
A4	8.87	22	8.8711	22	Valid
A5	20.98	5	20.9769	5	Valid
A6	14.07	13	14.0716	13	Valid
A7	13.63	16	13.6296	16	Valid
A8	8.22	23	8.2187	23	Valid
A9	19.17	6	19.1735	6	Valid
A10	18.19	7	18.1912	7	Valid
A11	16.30	9	16.2977	9	Valid
A12	2.60	24	2.6047	24	Valid
A13	15.13	10	15.1340	10	Valid
A14	12.03	17	12.0302	17	Valid
A15	13.89	15	13.8894	15	Valid
A16	9.39	21	9.3891	21	Valid
A17	24.19	4	24.1915	4	Valid
A18	17.83	8	17.8309	8	Valid
A19	14.23	12	14.2317	12	Valid
A20	35.38	2	35.3781	2	Valid
A21	10.68	20	10.6767	20	Valid
A22	13.99	14	13.9882	14	Valid
A23	1.75	25	1.7483	25	Valid
A24	11.37	19	11.3689	19	Valid
A25	26.84	3	26.8445	3	Valid

4. CONCLUSION

Hybrid model in the development of decision support system using AHP and SAW can help the management at college to do the ranking of study program. Amounted 7 criteria were used in the developed model to carry out the ranking of study program existed at Sriwijaya State Polytechnic. The actual weighting model used also could give the weight of criteria to be more objective because the data used in the weighting was attached to each study program. This actual weight is obtained based on data attached to each study program based on predetermined criteria, without requiring special interpretation and preferences from a decision maker. Using actual weights also does not require normalization that considering cost and benefit aspects, so the calculation process becomes simpler. This DSS model can be used by the college management as another alternative in carrying out the ranking of study program which is not only based on the accreditation rank gained by the study program.

ACKNOWLEDGEMENTS

The authors would like to thank the Directorate General of Vocational Education, Ministry of Education, Culture, Research, and Technology for providing research grants for foundation research schemes for the 2023 fiscal year with contract number: 158/SPK/D.D4/PPK.01.APTV/VI/2023.

REFERENCES

[1] I. V. Shelehov, D. V. Prylepa, Y. O. Khibovska, and M. S. Otroshcenko, "Machine Learning Decision Support Systems for Adaptation of Educational Content To the Labor Market Requirements," *Radio Electron. Comput. Sci. Control*, no. 1, p. 62, 2023, doi: 10.15588/1607-3274-2023-1-6.

[2] A. H. Abbasi, S. U. Rehman, and T. Ali, "Multi-Criteria Decision Support System for Recommendation of Ph.D. Supervisor," *Found. Univ. J. Eng. Appl. Sci.*, vol. 1, no. June 2020, 2021, doi: 10.32604/x.2021

[3] V. Kostoglou, N. Ploskas, M. Vassilakopoulos, and V. E. Tsantopoulou, "Analysis and design of a web-based decision support system for choosing higher education studies," *Yugosl. J. Oper. Res.*, vol. 24, no. 3, pp. 399–414, 2014, doi: 10.2298/YJOR140411025K.

[4] M. Anwar and E. Sabrina, "Design of decision support system in determining the single student tuition fee in higher education," C*OUNS-EDU Int. J. Couns. Educ.*, vol. 5, no. 4, pp. 185–195, 2020, doi: 10.23916/0020200531440.

[5] D. T. Widyanti, A. T. Putra, and M. A. Muslim, "Decision Support System for the Success of Education Program at Secondary School Level using Combination of K-Medoids Clustering and TOPSIS," *J. Adv. Inf. Syst. Technol.*, vol. 2, no. 1, pp. 33–40, 2020, doi: 10.15294/jaist.v2i1.44366.

[6] N. Komleva, V. Liubchenko, S. Zinovatna, and V. Kobets, "Decision support system for quality management in learning process," *CEUR Workshop Proc.*, vol. 2711, pp. 430–442, 2020.

[7] S. Akbar and H. Awang, "Decision Support System Course in Developed and Developing Countries," *Lett. Inf. Technol. Educ.*, vol. 3, no. 1, pp. 41–48, 2020, doi: 10.17977/um010v3i12020p041.

[8] R. R. Shalabi "The Importance and Applications of Decision Support Systems (DSS) in Higher Education," 2020.

[9] V. P. Bresfelean, N. Ghisoiu, R. Lacurezeanu, M. Pop, M. Vlad, and O. Veres, "Designing a Dss for Higher Education Management," in *Proc. First Int. Conf. Comp. Supp. Educ.*, 2011, pp. 335–340, doi: 10.5220/0002012603350340.

[10] H. A. A. Alshadoodee, M. S. G. Mansoor, H. K. Kuba, and H. M. Gheni, "The role of artificial intelligence in enhancing administrative decision support systems by depend on knowledge management," *Bull. Electr. Eng. Informatics*, vol. 11, no. 6, pp. 3577–3589, 2022, doi: 10.11591/eei.v11i6.4243.

[11] B. Jabir, N. Falih, and K. Rahmani, "HR analytics a roadmap for decision making: Case study," *Indones. J. Electr. Eng. Comput. Sci.*, vol. 15, no. 2, pp. 979–990, 2019, doi: 10.11591/ijeecs.v15.i2.pp979-990.

[12] A. K. Hamoud, M. K. Hussein, Z. Alhilfi, and R. H. Sabr, "Implementing data-driven decision support system based on independent educational data mart," *Int. J. Electr. Comput. Eng.*, vol. 11, no. 6, pp. 5301–5314, 2021, doi: 10.11591/ijece.v11i6.pp5301-5314.

[13] J. Chanwijit, W. Lomwongpaiboon, O. Dowjam, and P. Tangworakitthaworn, "Decision Support System for Targeting Higher Education," *Proc. 2016 5th ICT Int. Student Proj. Conf. ICT-ISPC 2016*, pp. 154–157, 2016, doi: 10.1109/ICT-ISPC.2016.7519259.

[14] A. Santoso *et al.*, "Superior hybrid corn variety selection using AHP method," *Int. J. Eng. Adv. Technol.*, vol. 8, no. 6, pp. 1018–1021, 2019, doi: 10.35940/ijeat.F1309.0886S219.

[15] J. F. Figueroa-Perez, J. C. Leyva-Lopez, L. C. Santillan, E. O. Pérez Contreras, and P. J. Sánchez, "The use of marketing decision support systems for new product design: A review," *Int. J. Comput. Intell. Syst.*, vol. 12, no. 2, pp. 761–774, 2019, doi: 10.2991/ijcis.d.190624.001.

[16] S. Riyanto, J. Indonesia, and R. Maulana, "Decision Support System to Help Educational Institutions Determine the Best Learning Method," in *Proc. 3rd Asia Pacific Int. Conf. Ind. Eng. Oper. Man.*, 2022, pp. 191–198.

[17] M. M. A. Bhuiyan and A. Hammad, "A Hybrid Multi-Criteria Decision Support System for Selecting the Most Sustainable Structural Material for a Multistory Building Construction," *Sustain.*, vol. 15, no. 4, 2023, doi: 10.3390/su15043128.

[18] K. Magade and A. Sharma, "Automating Decision Process of Overnight Patient Care Using Hybrig Machine Learning Algorithms," *J. Data Acquis. Process.*, vol. 38, no. 2, pp. 382–392, 2023, doi: 10.5281/zenodo.7766349.

[19] Noviana, M. B, and S. Ramadhani, "Decision Support System for Selection of the Superior Mango Seeds Using Web-based Analytical Hierarchy Process (AHP) Hybrid Simple Additive Weighting (SAW) Method," *Tepian*, vol. 3, no. 2, pp. 76–84, 2022, doi: 10.51967/tepian.v3i2.852.

[20] L. Sumaryanti, Nurcholis, and L. Lamalewa, "Aplication of Hybrid Method for Superior cattle selection using Decision Support System," *E3S Web Conf.*, vol. 328, 2021, doi: 10.1051/e3sconf/202132803003.

[21] M. D. Soufi, T. Samad-Soltani, S. S. Vahdati, and P. Rezaei-Hachesu, "Decision support system for triage management: A hybrid approach using rule-based reasoning and fuzzy logic," *Int. J. Med. Inform.*, vol. 114, pp. 35–44, 2018, doi:

10.1016/j.ijmedinf.2018.03.008.
[22] R. H. M. Azmi, Y. Sonatha, and D. Meidelfi, "Hybrid of Ahp and Topsis for Loan Approval Decision," *J. Theor. Appl. Inf. Technol.*, vol. 96, no. 13, 2018.
[23] D. Wahyuni and M. R. Wayahdi, "Decision Support System Determining the Best Private Universities Using the Analytical Hierarchy Process Method (Case Study:LLDIKTI Area I North Sumatra)," *Infokum*, vol. 10, no. 1, pp. 244–252, 2021.
[24] S. Kasap, D. Abbas, M. Khajah, and M. Ashknani, "Developing a knowledge-driven decision support system for university/college selection problem in Kuwait," *Int. J. Inf. Educ. Technol.*, vol. 10, no. 1, pp. 20–25, 2020, doi: 10.18178/ijiet.2020.10.1.1333.
[25] A. R. Mamat *et al.*, "Modelling decision support system for selection maahad tafiz center using analytical hierarchal analysis," *Indones. J. Electr. Eng. Comput. Sci.*, vol. 13, no. 1, pp. 35–40, 2019, doi: 10.11591/ijeecs.v13.i1.pp35-40.
[26] Mardison, A. Ramadhanu, L. N. Rani, and S. Enggari, "Hybrid DSS for recommendations of halal culinary tourism west Sumatra," *IAES Int. J. Artif. Intell.*, vol. 10, no. 2, pp. 273–283, 2021, doi: 10.11591/ijai.v10.i2.pp273-283.
[27] N. Tamsir and S. Alam, "Decision Support Sistems (Dss) Determining Department Using Naive Bayesian Algorithm," *J. Inf. Technol. Its Util.*, vol. 1, no. 1, p. 1, 2018, doi: 10.30818/jitu.1.1.1690.
[28] T. Oktavia and E. D. Madyatmadja, "Decision support system to help in determining the study program concentration for higher education institution," *J. Telecommun. Electron. Comput. Eng.*, vol. 10, no. 1–9, pp. 77–80, 2018.
[29] A. Alowaigl, K. H. A. Al-Shqeerat, and M. Hadwan, "A multi-criteria assessment of decision support systems in educational environments," *Indones. J. Electr. Eng. Comput. Sci.*, vol. 22, no. 2, p. 985, 2021, doi: 10.11591/ijeecs.v22.i2.pp985-996.
[30] I. Prasetyaningrum, K. Fathoni, and T. T. J. Priyantoro, "Application of recommendation system with AHP method and sentiment analysis," *Telkomnika (Telecommun. Comput. Electron. Control.)*, vol. 18, no. 3, pp. 1343–1353, 2020, doi: 10.12928/TELKOMNIKA.v18i3.14778.
[31] M. M. Amin, A. Sutrisman, and Y. Dwitayanti, "Group decision support system model to determine supervisor lecturers for student creativity programs," *Bull. Electr. Eng. Informatics*, vol. 12, no. 4, pp. 2484–2494, 2023, doi: 10.11591/eei.v12i4.4784.
[32] Khairul, M. Simaremare, and A. P. U. Siahaan, "Decision Support System in Selecting The Appropriate Laptop Using Simple Additive Weighting," *Int. J. Recent Trends Eng. Res.*, vol. 2, no. 12, pp. 215–222, 2016.
[33] E. K. Zavadskas, K. Govindan, J. Antucheviciene, and Z. Turskis, "Hybrid multiple criteria decision-making methods: A review of applications for sustainability issues," *Econ. Res. Istraz.*, vol. 29, no. 1, pp. 857–887, 2016, doi: 10.1080/1331677X.2016.1237302.

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