ACHIEVEMENT STUDENT SELECTION SYSTEM USING THE SAW METHOD AND WSM METHOD

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Abstract— Higher education is an academic establishment that prepares students for the workforce by imparting both theoretical knowledge and practical skills, shaping them into educated individuals ready for professional life. One way to encourage increased student competence is to implement a selection of students with good achievements in terms of academic and non-academic abilities. The assessment of outstanding students has been widely implemented, but the system needs to be criteria-based. This research develops a Decision Support System, which makes it easier and helpful for the Dean and head of the department to decide on outstanding students. The study used 2 Multi-Criteria methods. The two methods of the applied multi-criteria concept The Simple Additive Weighting and Weighted Sum Model are applied to assess 22 students UIN Sayyid Ali Rahmatullah Tulungagung, enhancing their readiness for the job market by refining their theoretical understanding and practical capabilities through higher education. Students come from 4 different faculties taken randomly. These faculties include tarbiyah, ushuluddin, economics and sharia each semester 6. The outcomes from both techniques exhibit a high level of similarity. MHS8 and MHS10 secure the top two spots, with variations emerging in subsequent rankings when considering the combined criteria of the two methods. Based on the system test results, the system's output using these two methods produces students with achievements in almost the same order, and students with achievements made from the system are in accordance with conditions in the field that these students really have achievements.

Keywords: college student, criteria, decision support system, university.

Intisari— Institusi pendidikan tinggi melatih mahasiswa sebagai subjek pembelajaran untuk menghadapi dunia kerja dengan memperoleh keterampilan teoritis dan praktis yang diperlengkapi. Salah satu cara untuk mendorong peningkatan kompetensi mahasiswa adalah menerapkan seleksi terhadap mahasiswa berprestasi baik dari kemampuan akademik dan non akademik. Penilaian mahasiswa berprestasi sudah cukup banyak diterapkan namun sistem yang digunakan belum berbasis kriteria. Penelitian ini mengembangkan Decision Support System yang memiliki fungsi dasar untuk mempermudah dan membantu Dekan maupun ketua jurusan untuk memutuskan mahasiswa berprestasi. Baik Dekan maupun Ketua Jurusan tidak perlu terjun langsung untuk menyebar kuesioner, namun cukup dengan menggunakan Decision Support System. Hasil studi ini menunjukkan identifikasi mahasiswa yang berhasil. Penelitian melibatkan penerapan 2 model Multi Criteria. Kedua teknik ini digunakan dalam sistem yang berfungsi sesuai dengan keperluan masing-masing. Dua pendekatan multi kriteria, yaitu Simple Additive Weighting dan Weighted Sum Model, diaplikasikan pada data 22 mahasiswa dari UIN Sayyid Ali Rahmatullah Tulungagung. Mahasiswa berasal dari 4 fakultas yang berbeda yang diambil secara acak. Fakultas tersebut antara lain tarbiyah, ushuluddin, ekonomi dan syariah masing-masing semester 6. Output dari kedua pendekatan hampir identik; MHS8 dan MHS10 secara berurutan menempati peringkat pertama dan kedua. Namun, peringkat selanjutnya menunjukkan variasi di antara kedua metode multi kriteria tersebut. Berdasarkan evaluasi sistem, hasil dari sistem yang memanfaatkan kedua pendekatan tersebut menunjukkan mahasiswa yang unggul dengan urutan yang serupa, menandakan

kualitas yang sebanding dari kedua metode tersebut. Mahasiswa berprestasi yang dihasilkan dari sistem sesuai dengan kondisi di lapangan bahwa mahasiswa tersebut benar-benar memiliki prestasi.

Kata Kunci: *mahasiswa, kriteria, decision support system, perguruan tinggi.*

INTRODUCTION

Education is a means of facing the future for a nation and state. Good quality education will influence the level of human resources in a country. Higher education is an institution after secondary education that produces output, namely students. Higher education is taken after upper secondary education. Higher education is taken after upper secondary education. The primary objective of higher education is to nurture students into individuals who possess strong faith and devotion to God, uphold ethical values, maintain physical well-being, acquire knowledge, demonstrate creativity, independence, skillfulness, competence, and cultural awareness, all for the benefit of their nation [1]. Students, as the output of a university, must have abilities that support themselves to achieve a bright future. Competition in work or employment is currently very tight, making university graduates have to be more creative and intelligent. Being creative and innovative is a demand and obligation for today's students. The increasing number of graduates from a university means that universities must be clever in improving the abilities of their students.

The directives provided by the Ministry of Research, Technology, and Higher Education concerning the Criteria for Selecting Exceptional Undergraduate Students, The purpose of choosing exceptional undergraduate students is to generate graduates proficient in various fields of science and technology, thereby serving national interests and enhancing the country's competitiveness [1]. This assessment of student achievement needs to be carried out not only for the nation's benefit but also to improve the quality of higher education and the quality of students themselves. Students are expected to have competence, namely in the form of comprehensive intelligence, which can balance hard and soft skills, among others. Students can obtain such abilities by participating in extracurricular, co-curricular and extracurricular activities. The abilities in question can be narrowed down to 2: academic and non-academic. Academic abilities are the abilities that students gain in college while carrying out college activities.

Meanwhile, non-academic abilities are abilities obtained from outside of college. In the current era, with the increasing development of information technology, students must be more innovative in following recent developments, which must be connected to technology. Industrial era 4.0 is a term that is familiar in the current era. Therefore, it has become a demand for college graduates to be able to integrate knowledge at college with technology.Rapidly developing information technology influences most human activities. So that conventional human activities can be replaced by a computerized system. One of them is assessing the ability of outstanding students using an automated system. All lecturers and higher education leaders can monitor the transparency of each student's grades by accessing the website-based Decision Support System (software). The Decision Support System can be accessed using a wireless network with an internet basis to connect software (browser) and hardware (PC).

The system displays grades for each student based on achievements during the lecture period. This system can also be accessed by all students using the internet network, provided the leadership has a policy regarding access rights to the system. Following the description above, this research uses a Decision Support System to assess exceptional students, while the mathematical method analysis uses the Multi Criteria Technique. The Multi-Criteria technique applied in this research is a combination technique between 2 methods, which are part of the Multi-Criteria Decision Making technique, including the Simple Additive Weighting method and the Weighted Sum Model. A Decision Support System, often known as a DSS, is part of an information system that aims to provide decision recommendations to managers or leaders in an institution [2] [3]. The Multi-Criteria Decision Making technique is part of Artificial Intelligence, so by using this technique, the mathematical analysis does not need to be done conventionally or manually by humans. The Multi-Criteria Decision Making technique is a problem-solving technique using criteria as a reference [4] [5].

The Multi-Criteria method used in research consists of 2 types, namely the SAW and WSM methods. The two methods were combined to determine the effectiveness level of both, so researchers conducted research regarding assessing student achievement and testing the superiority or effectiveness of the SAW and WSM methods. Apart from that, by using these two methods, this research will develop rapidly and can be continued by other researchers. The Simple Additive Weighting method focuses on weighting each criterion based on decisions from the

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leadership. The Weighted Sum Model method focuses on the combination of multiplication in the addition process and remains based on the weight value of each criterion. Both have the advantage of a practical calculation process and produce output in numbers, so they are accurate. The study on the Decision Support System for Exceptional Student Selection through the Simple Additive Weighting Method highlighted that the current manual approach to identifying outstanding students at Cileungsi Muhammadiyah College of Technology is time-consuming and poses potential risks due to the lengthy data processing involved. In the evaluation process, mistakes can arise. The research employs the Simple Additive Weighting (SAW) method.

This method focuses on assigning weight values to individual attributes and subsequently ranking the alternatives to identify the most optimal choice. Application test results based on calculations of the 6 aspects contained in ISO 9126 have a percentage value of 70.41% on a good scale; of these 6 aspects, the one with the highest percentage value is maintenance with a percentage value of 74.3% and is expressed on a good scale. The difference with our research is that the criteria applied involve TOAFL scores [6]. The study titled "Decision Support System for Identifying Outstanding Students Utilizing the Simple Additive Weighting (SAW) Method at Telkom Purwokerto Vocational School". This research states that the selection of outstanding students using the system can increase the objectivity of the assessment so that the results produced are right on target. The system implements the SAW method based on several criteria, making it easier for teachers to carry out calculations. The difference with our research lies in the decision maker. In this research, the testing process carried out by the decision maker has yet to be discussed, even though it uses the DSS concept [7].

The research entitled the Selection of the Best Vocational School Students in Medan City Using the Weighted Sum Model Method stated that the system was designed to assist the local Education Department in formulating high-achieving vocational school students. This system is helpful because the number of vocational school students is so large that it can slow down the performance of the Education Department in formulating outstanding students. The research employs the Weighted Sum Model as its methodology. A distinctive aspect of our study lies in the criteria development phase, where our criteria align with the guidelines set by the Ministry of Research, Technology, and Higher Education [8]. The study titled "Multi-Criteria Ranking for

Distribution System Planning Using the Integrated Weighted Sum Model with HOMER". In this research, a distribution system was carried out to select cost-effective electricity. The criteria used in this research include cost, renewable energy, and network energy. Several criteria will be processed using the Weighted Sum Model method to produce the best-distributed system for selecting economical electricity. In this research, all criteria and research methods refer to Roorke's data in exploring the configuration of the distributed system [9].

The study titled "Utilizing the Weighted Sum Model Methodology for Selecting Titanium Alloys in Biomedical Applications". This research discusses the choice of production materials for manufacturing businesses. In the previous condition, the problem was an error in selecting goods used as materials for manufacturing activities. One of the activities in question is the aviation business. Errors in material selection will result in unstable product performance and failure in the assembly process. So, In this study, the methodology employed is the Weighted Sum Model was used to determine suitable titanium materials to produce good manufactured products [10]. Based on previous research, the purpose or usefulness of applying the methodologies of Simple Additive Weighting and Weighted Sum Model is to provide decision recommendations to the dean or head of the study program to determine outstanding students.

MATERIALS AND METHODS

Research methods are the stages applied in the research process. One of the aims of the research method is to make it easier for researchers to conduct research from the initial to the final stages so that research activities can proceed sequentially.

Source: (Research Result,2024)
Figure 1. Research Method

According to Figure 1, the research process initiates by identifying issues, specifically recognizing societal problems, followed by their systematic processing within the system. The issues studied are, of course, supported by previous research that researchers have carried out. The focal point of this study revolves around evaluating exceptional students in accordance with the criteria outlined by the Ministry of Research, Technology, and Higher Education concerning the Selection Guidelines for Outstanding Undergraduate Students.

The next stage is needs analysis, which covers meeting the needs required in the research process. The conditions in question consist of supporting literature, designing system components, and formulating the data needed for research. The literature used in this research comes from previous journals on almost the same topic at both local and international levels. The system design must be mapped out first, including display design, data storage, and processing.

Data collection involves gathering information that aids in the research procedure. The data used in the research were 22 students from Sayyid Ali Rahmatullah Tulungagung State Islamic University from various study programs. Students become respondents to questionnaires provided by researchers. The survey includes research criteria with varying weight values based on the significance level of the criteria. Students become respondents to questionnaires provided by researchers. The questionnaire contains research criteria with different weight values according to the level of importance of the criteria. The students who were the objects of the research came from 4 faculties, including tarbiyah, ushuluddin, sharia, and economics, who were taken randomly.

The system design stages consist of several types: database and interface. A database is an information system-supporting application that stores and processes data. However, before the database is implemented, the relationships between the tables must first be designed. The interface design communicates between the user (admin/user) and the system. A visual programming language that suits user needs is used in interface design.

The system creation stage is the core stage of software development—creating a system containing coding whose function combines database and interface. Programming languages are very functional at the system creation stage. A programming language is used to translate the multi-criteria Decision-making computational method so that it can be run on applications. Solving the Multi Criteria Decision Making computational method requires quite a long process and time, sos stage is the most challenging stage.

System evaluation is the final stage involving experts who review the system that has been completed according to the research topic. The experts involved in the system evaluation stage are academics and experts in the digital economy. These two experts will complement each other regarding the ideal application of this research.

A. Multi Criteria Decision Making

The concept of multi-criteria decision-making is a commonly employed technique within the framework of decision support systems. It involves utilizing numerous criteria for computations and analysis, with these criteria tailored to the specific issue under investigation [11][12].

B. Simple Additive Weighting Method

The Simple Additive Weighting method is a component of Fuzzy Multi-Attribute Decision Making, encompassing a mathematical normalization process of the decision matrix (x) to determine a scale calculation for comparison against all alternative values, followed by the computation of the preference value [13], [14] .
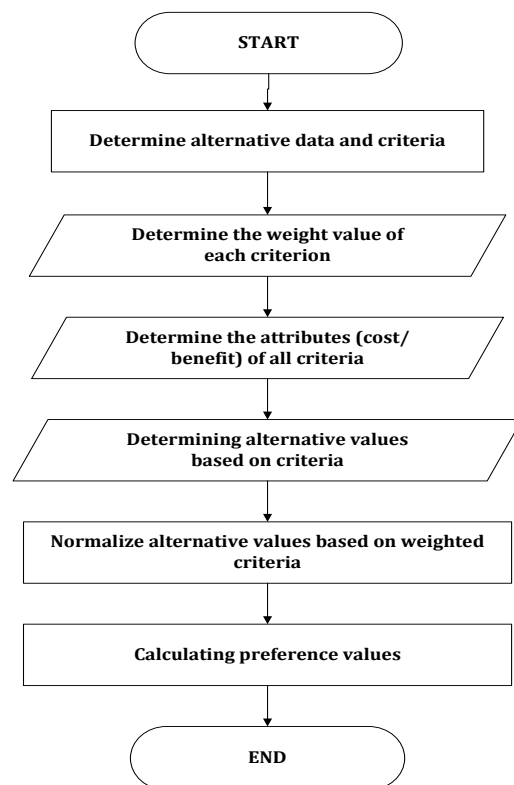
Source: (Research Result,2024)
Figure 2. Flowchart of the Simple Additive Weighting method

Based on Figure 2, the stages of the Simple Additive Weighting method process are depicted. Starting from determining alternative data and criteria to weighting values for each measure based on expert considerations.

Determining the costs and benefits for each criterion is then continued by normalizing alternative values based on several criteria.

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\underset{i}{Max}\ x_{ij}} & \text{if } j \text{ is the benefit attribute} \\ \dfrac{\underset{i}{Min}\ x_{ij}}{x_{ij}} & \text{if } j \text{ is the cost attribute} \end{cases} \quad (1)$$

Information :
rij = normalized performance rating value
xij = attribute value
Max Xij = the most significant value of each criterion
Min Xij = smallest value of each criterion
Benefit = if the most significant value is best

Each alternative has a normalization value based on the type of attribute. After going through the normalization process, the final process is calculating the preference value. For the formula according to equation 2.

$$V_i = \sum_{j=1}^{n} w_j \ r_{ij} \quad (2)$$

Information :
v = preference value
w = criteria weight
r = normalized value

Calculating the preference value is the sum of the results of multiplying each criterion weight with the normalized value. The stages in the Simple Additive Weighting method can streamline the human performance process computationally [15]. Apart from that, this method is also able to help various parties, especially agencies or institutions, in making decisions[16].

C. Weighted Sum Model Method
The Weighted Sum Model method uses several Multi-Criteria Decision Making methods. This method is usually applied in Decision Support Systems to assist and provide decision recommendations for managers or leaders [17]. The mathematical process carried out in this method is to multiply the criteria weight by the alternative value. The mathematical operation of bearing the weight value with the alternative deal will provide an effective solution to the decision-maker with satisfactory results [18].

Mathematical calculations using the Weighted Sum Model method are effective in helping managers make decisions in various cases, provided that there is numerical data from the patients studied [19]. The Weighted Sum Model method employs two key variables: alternative data derived from the study's data and criteria data representing variables pertinent to the research context. These variables are interconnected, requiring input from the decision-maker to ascertain the weight value for each criterion, with each criterion assigned a distinct weight value. Mathematical calculations using the Weighted Sum Model method are following equation 3.

$$_{Ai}WSM - score = \sum_{j-1}^{n} w_j x_{ij}, for\ i$$
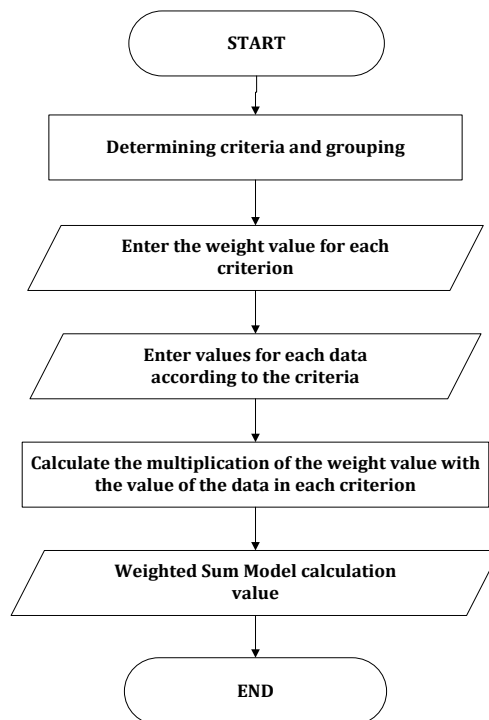$$= 1,2,3\ \dots\dots \quad (3)$$

Information :
n = number of criteria
wj = weight of each criterion
xij = matrix value x

For the stages of the Weighted Sum Model method, see Figure 3.

Source: (Research Result,2024)
Figure 3. Flowchart of the Weighted Sum Model method

RESULTS AND DISCUSSION

A. Alternative Data and Criteria

The research began by determining the criteria used to assess outstanding students. The criteria used in the study are part of the Guidelines for Selection of Outstanding Students.

Table 1. Assessment Criteria

No	Criteria	Criterion Group
1	IPK value	Academic
2	Performance	Non-Academic
3	Organizational Activeness	Non-Academic
4	TOEFL score	Academic
5	TOAFL scores	Academic

Source:(Research Result,2024)

The criteria applied according to Table 1 consist of academic and non-academic criteria. Academic criteria are criteria that support student educational activities. Meanwhile, non-academic criteria are not related to students' academic activities but can support students' abilities.

Table 2. Criteria and their components

No	Criteria	Attribute	Value Weight
1	IPK value	*Benefit*	5
2	Performance	*Benefit*	4
3	Organizational Activeness	*Cost*	2
4	TOEFL score	*Benefit*	4
5	TOAFL scores	*Benefit*	3

Source:(Research Result,2024)

Based on Table 2, the criteria components consist of attributes and weight values. Features consist of 2 types, including benefits and costs. Meanwhile, the number-based assessment uses a standard Likert scale. The Likert scale determines the criteria weight values and values for each alternative data.

Table 3. Likert Scale

Scale	Information
5	Very good
4	Good
3	Enough
2	Not enough
1	Very less

Source:(Research Result,2024)

Based on Table 3, the Likert scale used in the research is an interval scale. There are five relevant scale levels used when filling out the questionnaire. The system processes this scale-based value.

B. Implementation of the Simple Additive Weighting Method

After determining the value for each alternative, the mathematical stage in the Simple Additive Weighting method is to determine the normalization value, which involves the alternative value and the criteria weight value.

Table 4. Normalized Values

Code	C1	C2	C3	C4	C5
MHS1	1	0.6	0.4	1	0.75
MHS2	1	0.8	0.67	0.75	0.75
MHS3	1	0.6	0. 67	0.75	0.75
MHS4	1	0.6	1	0.75	0.75
MHS5	1	0.6	0.5	0.75	0.75
...	....	....	....	....	....
MHS22	0.8	0.6	1	0.75	0.75

Source:(Research Result,2024)

Based on Table 4, the normalization value is based on each criterion. The data processed reached the normalization stage for 22 students. After the normalization stage, the final step calculates the vector value V or preference value. The calculation results refer to Equation 2 and are presented in Table 5.

Table 5. Preference Values/Vector V

Code	Preference Value
MHS1	14.45
MHS2	14.78
MHS3	13.98
MHS4	14.65
MHS5	13.65
...	....
MHS22	13.65

Source:(Research Result,2024)

Table 5 presents the final value or preference value (vector V) according to the calculation of the Simple Additive Weighting method. From the results of calculating preference scores, a ranking process can be carried out to determine which students have the best scores.

Table 6. Best Students based on the Simple Additive Weighting method

Ranking	Code	Value
1	MHS8	16.8
2	MHS10	16.25
3	MHS16	15.05
4	MHS19	15.04
5	MHS2	14.78
...	...	...
22	MHS18	12.45

Source:(Research Result,2024)

Based on Table 6, the best values obtained using the Simple Additive Weighting method are MHS8, MHS10, and MHS16, respectively.

C. Implementation of the Weighted Sum Model Method

The Weighted Sum Model calculation's alternative values and criteria weight values are the same as the Simple Additive Weighting method.

This is because this research uses the same data with different criteria methods. In the Weighted Sum Model method, the weighted criteria values are multiplied by alternative values using calculations according to equation 3.

Table 7. Calculation values for the Weighted Sum Model method

Code	Final value
MHS1	72
MHS2	68
MHS3	64
MHS4	62
MHS5	66
...	....
MHS22	57

Source:(Research Result,2024)

Table 7 presents the final value of the Weighted Sum Model method for each data alternative. The final stage is to find out the best alternative data by sorting it.

Table 8. Best Students based on the Weighted Sum Model method

Ranking	Code	Value
1	MHS8	83
2	MHS10	78
3	MHS19	76,3
4	MHS16	76
5	MHS1	72
...	...	...
22	MHS22	57

Source:(Research Result,2024)

Based on Table 8, student scores in order based on the Weighted Sum Model method calculation are MHS8, MHS 10, and MHS19.

CONCLUSION

Drawing from the prior chapter's research, the top student scores were nearly identical when employing two distinct methods. The first highest value is MHS8, and the second highest is MHS10. The Decision Support System can be accessed using a wireless network with an internet basis to connect software (browser) and hardware (PC). The system displays grades for each student based on achievements during the lecture period. This system can also be accessed by all students using the internet network, provided the leadership has a policy regarding access rights to the system. With an open system, intervention from any party will be minimized because the values presented are valid, and systematic data is processed using a multi-criteria-based method. All users can access the system to reduce the perception of subjectivity. The system can be accessed from anywhere as long as the computer device is connected to the internet.

The author considers that this research still needs improvement, so it requires suggestions from other researchers, and there is a need for further development, especially in the application of 2 Multi-Criteria Decision-Making methods, namely Simple Additive Weighting and Weighted Sum models for other cases.

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