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Combining Analytical Hierarchy Process Method - Profile Matching Method for the Best Dean's List Selection

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Abstract

Determining the best dean's list is one of the steps to motivate students to complete their studies at a tertiary institution. However, the process of determining the best candidate dean's list is not an easy thing to make decisions consistently and transparently. So, in this study we combined the AHP and Profile Matching Method, as well as a linear interpolation model with criteria grade point averages (GPA) obtained, subjects taken and criteria repeated subjects. This study aims to provide specific knowledge about how to combination of the AHP-Profile Matching method and the linear interpolation model in building the best Dean's List decision support system. Where the two methods work together to determine the best dean's list according to their respective rules, namely the AHP method to calculate priority levels and criteria consistency values, while the Profile Matching method, to match data values with target data, determine the weight of competency GAP values, calculate the ranking value of each candidate with a priority level value obtained from the results of the calculation by AHP method, and calculating the mapping weight value in decimal form can use the linear interpolation model which will be used as the weight of the competency GAP value. The results showed that the two methods were successfully combined and were able to determine the consistency ratio for each criterion rating scale of 0,030, and were able to determine the best dean's list of 52 candidates, with the highest ranking value of 5,388.

Keywords: Analytical Hierarchy Process; Profile Matching; Linear Interpolation; Dean's List

Introduction

The development of technology and information at this time is very important in taking part in various aspects, including aspects of education and community service, especially in higher education institutions. Where a higher education institution does not only concentrate on education, teaching, and community services but also motivates students in any form including awarding such as dean's list. Where the dean's list is a categorization of students in a tertiary institution that has a good track record, according to the provisions of the institution to obtain awards within a certain period, to be able to motivate other students to be diligent in completing their education (Bader, 2011).

However, the process of determining students or candidates to obtain the Dean's list is not an easy thing, because it involves various aspects such as consistency and transparency in decision-making according to established criteria. For the decision-making process to remain consistent and transparent, our research proposes several methods to be combined to support decision-making, with commonly used criteria, namely the GPA obtained (Challenge, 2022), the subject taken, and repeated subjects.

There is a large proportion of research related to decision-making, which starts with the definition of a decision support system (Turban et al., 2007) then is developed with various methods such as the AHP Gupta (2015) used to determine a surgical hospital the best, Noshad (2019) used to determine the mix priority formula in making banana dough, Manurung (2020) used to determine employees who are eligible to get bonuses and the Profile Matching method Sunarti et al., (2017) for employee selection and acceptance of employees to occupy a position or vacancy, Tharo & Siahaan (2016) used to solve ranking problems, Sutedi et al., (2019) used to select training instructors. Until now, various methods that initially stand alone can be combined, such as the AHP-Profile Matching method Dhammayanti et al., (2019) used to select candidates for certain positions, Batubara & Sari (2021) used to select students to take part in high school level Olympiads, Akmaludin et al., (2022) used to select employees for promotion to positions Mahendra & Hartono, (2021) to determine the determination of student work practice, Handayani & Wardoyo, (2021) used for keyboard priority recommendations.

This research is different from several previous studies, although we also combined the AHP-Profile Matching method as described above. However, our research focuses on different objects and criteria to determine the best dean's list, by combining the analytical hierarchy process (AHP) method, the profile matching method, and the Linear Interpolation model.

Where the AHP method is used to determine the importance, level, weight, and consistent value of each criterion. While the profile matching method is used to match data values with predetermined target data, determine the weight of competency GAP values, and calculate the ranking level value of each candidate. Whereas Linear Interpolation is used to calculate the mapping weight values in the form of decimals, they are used as competency GAP value weights.

This research is composed of: Section 1 presents several problematic ideas that are interrelated with several previous studies. Section 2 describes the materials used and the proposed method offered. Section 3 Research results and analysis, and Section 4 current conclusions and further research.

Materials and Methods

Materials

In this study, we used secondary data, where the data provided by each department was in the form of summary data on student study results for the 2018-2019 academic year, which is available at the Dili Institute of Technology (DIT), as well as criteria data for students to obtain dean's list in the DIT education and teaching section as shown in Table 1. The criteria data in this study will be used as the target value.

Value Target	
Criteria Names	***Criteria Value***
GPA Obtain	4,00
Subject Taken	6
Repeated subjects	0

Table 1: Value Target.

The student selection process to obtain the dean's list begins with document selection in the form of a recapitulation of study results from each department, which is carried out by the faculty administration. The overall selection results obtained 52 students who were declared eligible to be processed to obtain the best dean's list in the academic year and submitted to the education and teaching department to determine.

State of art approach

The state-of-the-art approach in this study proposes two (2) methods, namely the analytical hierarchy process (AHP) method and the profile matching method, to be combined by going through several stages to obtain decision results as shown in Figure 1.

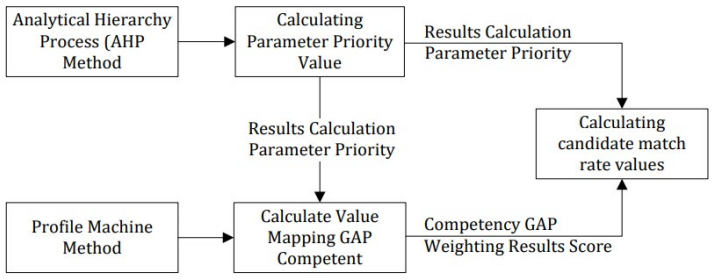

Figure 1: Propose Methods.

Analytic Hierarchy Process (AHP) Method

In solving this case using AHP, several stages were passed, namely.

a) Develop a hierarchical process structure for existing problems, as shown in Figure 2.

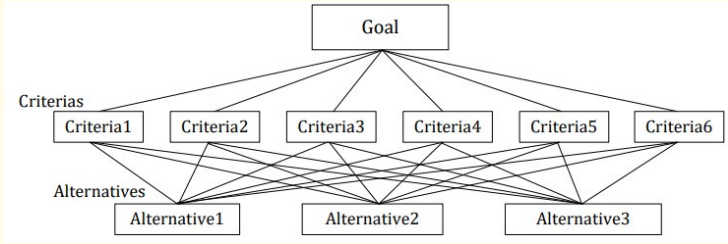

Figure 2: Structure of AHP (Saaty & Vargas, 2012).

b) Determine the pairwise comparison scale value of each parameter in each criterion with Table 2.

Intensity of Importance	***Definition Explanation***	***Definition Explanation***
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential of Strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is favored very strongly over another; its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	The intermediate value between the two adjacent judgments	When compromise is needed
Reciprocals of above	If activity I have one of the above non-zero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	A reasonable assumption

Table 2: The fundamental scale of absolute numbers (Sasty, 1990).

c) Perform matrix comparison calculations for each parameter with equation (1) (Saaty, 2008).

$$\begin{bmatrix} & A_1 & A_2 & \dots & \dots & A_n \\ A_1 & \frac{w_1}{w_1} & \frac{w_1}{w_2} & \dots & \dots & \frac{w_1}{w_n} \\ A_2 & \frac{w_2}{w_1} & \frac{w_2}{w_2} & \dots & \dots & \frac{w_2}{w_n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ . & . & . & \dots & \dots & . \\ A_n & \frac{w_1}{w_1} & \frac{w_1}{w_1} & \dots & \dots & \frac{w_n}{w_n} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ . \\ w_n \end{bmatrix} \qquad (1)$$

Where:

A1 ... *An* = kriteria / sub kriteria / alternatif program.

w1 ... *wn* = bobot dari kriteria / sub kriteria / alternatif program.

d) As well as determining the value of the consistency ratio from the results of the comparison of each criterion, with equations (2) and (3) as follows (Saaty & Vargas, 2012), where there is equation (2) calculates the consistency index (CI).

$$CI = \left(\frac{\lambda max - n}{n - 1}\right) \qquad (2)$$

Where:

CI = Consistency Index.

λmax = Eigenvalue Max.

n = Ordos Matrix.

While equation (3) calculates the consistency ratio of the value of each criterion.

$$CR = \frac{CI}{RI} \qquad (3)$$

Where:

CR = Consistency Ratio.

CI = Consistency Index.

RI = Random Index (seen Table 3).

If the CR value is more than 10%, then the data judgment must be corrected. However, if the consistency ratio value is ≤0.1, then the calculation results can be declared feasible or consistent to proceed to the next process. Where the Random Index can be obtained from Table 3.

N	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***.....***	***15***
R.I.	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49	.....	1.58

Table 3: Random consistency index (R.I.) (Saaty & Vargas, 2012).

Profile Matching Method

The use of profile matching method in this case is used for:

1) Calculating the competency GAP value with equation (4) (Sutedi et al., 2019).

$$GAP = Value\ Attribute - Value\ Targe \quad (4)$$

Where:

Values attribute = Real value owned by candidates.

Values target = Requirement value set.

2) Determine the weight of the competency GAP score for each criterion, using Table 4 (Soares, 2021).

No	***Difference (GAP)***	***Value Weight***	***Information***
1	0	6	Not GAP (competence as required)
2	1	6,5	The individual competence is excess of 1 level/individual competence is less than 1 level/level competence of individual excess 2 levels/level
3	-1	5	Individual competence is less than 2 levels/level the individual competence is 3 levels/level
4	2	4,5	Individual competence is less than 3 levels/level competence of individual excess 4 levels/level
5	-2	4	Individual competence is less than 4 levels/level
6	3	3,5	The individual competence is 5 levels/level
7	-3	3	Individual competence is less than 5 levels/level
8	4	2,5	Not GAP (competence as required)
9	-4	2	The individual competence is excess of 1 level/individual competence is less than 1 level/level competence of individual excess 2 levels/level
10	5	1,5	Individual competence is less than 2 levels/level the individual competence is 3 levels/level
11	-5	1	Individual competence is less than 3 levels/level competence of individual excess 4 levels/level

Table 4: GAP score weight.

In the process of converting the competency GAP values based on Table 5 , it is only used for integer GAP values. Meanwhile, the GAP value in decimal form uses a linear interpolation model, as follows (Epperson, 2013):

a) *GAP value weight* (*positive number*) = 5 - (*GAP mapping value x 1*) + 0.5 (5)

b) *GAP value weight* (*number 0*) = 5 - (*GAP mapping value x 1*) (6)

c) *GAP value weight* (*negative number*) = 5 - (*GAP mapping value x - 1*) (7)

Combining AHP Method and Profile Matching method

Using the AHP calculated value for the priority level of each parameter combined with the competency GAP weighted value from the Profile Matching method, to calculate the match level value (ranking) of each candidate proposed, with equation (8) (Soares, 2021).

$$Rangking = ((x1)\%_{*} N1) + ((x2)\%_{*} N2) + ((x3)\%_{*} N3) \quad (8)$$

Where:

N1 = First aspect value.

N2 = Second aspect value.

N3 = Value of the third aspect.

(*x*)% = Percent value entered.

Results and Discussion

Results

The process of the results of this research is based on the stages described in the previous State of the art approach, starting with the process of compiling a hierarchical structure for the problems that have been described, as shown in Figure 3.

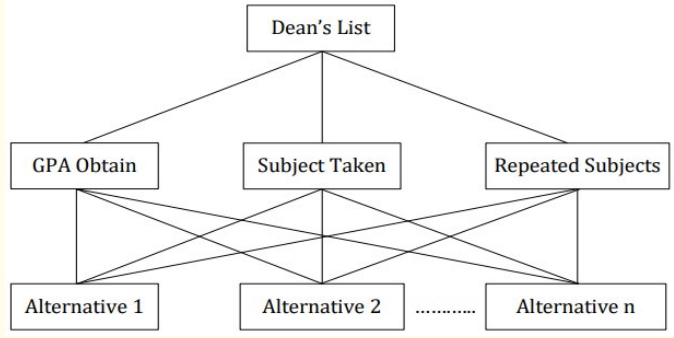

Figure 3: Dean's list hierarchy processes.

It should be noted that in Figure 3 the Alternative as the best dean's list candidate, in this case, is a student, who will be selected with the GAP criteria obtained, subject taken criteria, and repeated subject criteria to achieve the main goal, which is to get the best dean's list award

Build a comparison matrix

The matrix comparison between the criterion values in this study is following the concept of the analytical hierarchy process method with equation (1). Where the criteria value scale is given based on the level of importance of the criteria in Table 2 as shown in Table 5 below.

Goal	*GPA Obtain*	*Subject Taken*	*Repeated subject*
GPA Obtain	1	3	3
Subject Taken	0,333	1	2
Repeated subject	0,333	0,500	1

Table 5: Matrix Comparison.

The matrix comparison value in Table 7 shows that the GPA obtained criterion has a slightly more important value than the Subject Taken and Repeated subject criteria, while the subject took criteria have an important value that is close to the repeated subject criteria.

Calculation of the priority value of the criteria

Consideration of the comparison of paired matrices synthesized to obtain priority values for each criterion, using equation (1), so that the results of the priority criteria values can be seen in Table 6.

Goal	*GPA obtain*	*Subject taken*	*Repeated subjects*	*Total Rows*	*Priority Value*	*Result*
GPA Obtain	0,600	0,667	0,500	1,767	0,589	3,094
Subject taken	0,200	0,222	0,333	0,756	0,252	3,044
Repeated subject	0,200	0,111	0,167	0,478	0,159	3,023
Totals	1,000	1,000	1,000	3,000	1,000	9,162

Table 6: Calculate the value priority of the criteria.

Next, perform calculations to obtain a consistent ratio (CR) value through equations (2) and (3), where the n value in this study is 3 criteria and the I.R. obtained from table 4, so that the CR value is 0.030, as follows:

$CR = CI/RI$, where the CI value is obtained from equation (2)

$$CR = \frac{0,027}{0,89} = 0,30$$

The test results show that the value of the consistency ratio is ≤0.1, so it is said to be consistent enough to proceed to the next process.

Calculating the competency GAP value

This research will continue to calculate the competency gap value using the profile matching method with equation (4), because the value of the consistency ratio is feasible. Where the value attribute is the real value of each available alternative, while the target value is obtained from Table 1. For example, we only present five (5) alternatives out of 52 alternatives, so the results of the competency GAP values are shown in Table 7 below.

Student ID	*GPA obtain*	*Subject taken*	*Repeated subjects*
Stud_1	3,38	6	0
Stud_2	3,33	6	0
Stud_3	3,47	6	0
Stud_4	3,51	6	0
Stud_5	3,96	6	0

Value Target	*4,00*	*6*	*0*
Stud_1	-0,620	0	0
Stud_2	-0,670	0	0
Stud_3	-0,530	0	0
Stud_4	-0,490	0	0
Stud_5	-0,040	0	0

Table 7: Competency GAP value.

The weighting of competency GAP scores

Next, give the competency GAP weighting values obtained from the results of matching the two profiles according to table 4 for integer Gap result values, while for decimal competency Gap result values, you can use the linear interpolation model in equations (5), (6) or (7). So, the results of the weighted GAP values for each alternative with each criterion can be seen in Table 8.

Student ID	*GPA obtain*	*Subject taken*	*Repeated subjects*
Stud_1	4,380	6	6
Stud_2	4,330	6	6
Stud_3	4,470	6	6
Stud_4	4,510	6	6
Stud_5	4,960	6	6

Table 8: Results of the weight of the competence GAP score.

Combination of AHP and Profile Matching methods

To calculate the ranking results of 52 candidates with 3 criteria, you can combine the two methods, using equation (8), to produce a ranking value for each candidate as shown in table 9.

Student ID	*GPA obtain*	*Subject taken*	*Repeated subjects*	*Ranking*
Stud_1	2,579	1,511	0,956	5,046
Stud_2	2,550	1,511	0,956	5,017
Stud_3	2,632	1,511	0,956	5,099
Stud_4	2,656	1,511	0,956	5,123
Stud_5	2,921	1,511	0,956	5,388

Table 9: Final result of ranking.

Please note that of the 52 candidate dean's list with 3 criteria, our experimental results show that there is only one candidate who has the highest ranking value to get the best dean' s list score of 5,388.

Discussion

Table 10 shows a list of publications related to DSS topics using the AHP and, Profile Matching methods, sorted by year of publication. The table has four columns as follows: 1) Refs. research references; 2) Methods, which contain the method used to build the DSS; 3) Results, which show the results of the research; and 4) Limitations, which state the limitations of each research. The following paragraphs briefly explain the reviews related to the research in Table 10 and group them into one paragraph on a per-method basis.

In the research Gupta (2015) and Manurung (2020) used the AHP method to build a DSS with different parameters because the DSS was built for different cases. Where Gupta (2015) used AHP to determine the best surgical hospital, while Noshad (2019) used it to determine the mixed priority formula in making dough, but Gupta (2015) and research Noshad (2019) the results of the determination are based on manual calculations, so it needs to be tested on a software to be validated. As well as Manurung (2020) used to determine employees who are eligible to get bonuses at the end of the year at PT. BPR Perbaungan Hombar Makmur, the implementation results show that this method can determine eligible employees to get bonuses at the end of the year, but does not include the profile values of employees to match the target values of the company.

Research by Tharo & Siahaan (2016), Sunarti et al., (2017), and Sutedi et al., (2019) used the Profile Matching method to build DSS for different parameters and cases. Tharo & Siahaan (2016) uses the Profile Matching method to solve ranking problems, he claims that the calculation results have high accuracy in ranking, but there is no comparison with other algorithms or methods to compare accuracy value, and Sunarti et al., (2017) used this method for employee selection and employee acceptance to occupy a position or vacancy at PT. Asuransi Bina Dana Arta, Tbk Pekanbaru Branch, implementation results can speed up the process of selecting employees and recruiting employees, but other methods are needed to classify status as accepted and not for applicants to occupy a position or vacancy, as well as research by Sutedi et al., (2019) used for the selection of training instructors at Informatics and Business (IIB) Darmajaya, the result is a system for selecting training instructors, to increase the accuracy of determining professional appointment patterns, but another method is needed to determine the % Core Factors value and Secondary Factors because it is feared that if it is not consistent in giving the % Core Factors and Secondary Factors it will have an impact on the decision results.

Refs.	***Methods***	***Results***	***Limitations***
(Gupta, 2015)	AHP	The calculation results can help determine the best hospital for surgery	- Manual calculations that need to be tested on a software - Its application is limited to determining the best hospital for surgery
(Tharo & Siahaan, 2016)	Profile Matching	Calculations have high accuracy, but the difference tends to form a different sequence pattern so that the possibility of data having the same value is avoided	- An algorithm or other method is needed to compare the accuracy value in ranking
(Sunarti et al., 2017)	Profile Matching	Helping the process of employee selection and hiring decisions quickly, based on the highest ranking value. Where the greater the score of the final result of the application obtained, the greater it is the opportunity for applicants to occupy a position or vacancy	- The application of this method is limited to determining PT. Asuransi Bina Dana Arta, Tbk Pekanbaru Branch for employee selection. - An algorithm or other method is needed to classify whether or not applicants are accepted to occupy a position or vacancy
(Primasari et al., 2018)	AHP, Profile Matching and TOPSIS	Can determine the type of goat and the results of experiments that have been validated by experts, so that the DSS is valid and successfully represents expert judgment	- Another method is needed for weighting dependencies between criteria and sub-criteria

(Dhammayanti et al., 2019)	AHP, Profile Matching	Assist the Human Resources department of Kompas Gramedia HR in selecting candidates for placement in positions more quickly and precisely according to competence and performance	- Does not indicate when these two methods work together to fill in the weaknesses of each method to solve the case - Its application is limited to assigning employees to certain positions at Kompas Gramedia
(Noshad, 2019)	AHP	Able to determine the priority mix formula in making dough Pisan	- Manual calculation results that need to be tested on a software - Its application is limited to determining the priority formula for making banana dough
(Sutedi et al., 2019)	Profile Matching	Assisting the head of the training center in selecting training instructors, to increase the accuracy of determining professional appointment patterns	- Its application is limited to selecting training instructors at Informatics and Business (IIB) Darmajaya - Other methods are needed to determine % Core Factors and secondary factors
(Manurung, 2020)	AHP	The method applied is very good in determining eligible employees to get bonuses at the end of the year	- Does not include employee profile values to match the company's target values - Its application is limited to determining employees who are eligible to get bonuses from PT. BPR Perbaungan Hombar Makmur
(Batubara & Sari, 2021)	AHP, Profile Matching, Matrix Decomposit ion	Can help schools or teachers to select students to take part in the High School level Olympiad	- Does not indicate when these two methods work together to fill in the weaknesses of each method - No reason was given why these two methods should be combined - The application of the two methods, in this case, is limited to the selection of students to take part in the Olympiad at the senior high school level

(Mahendra & Hartono, 2021)	AHP-MAUT and AHP- PM	The results of manual calculations can determine the determination of student work practices	- Manual calculation results are not based on real-field data - Required other methods to test the accuracy of decision making - The manual calculation of the two methods in this case is limited to the selection of students' work practices
(Handayani & Wardoyo, 2021)	AHP, Profile Matching	Able to provide priority recommendations for mechanical keyboards according to user preferences	- Need other parameters to obtain better recommendation results - The application of both methods in this case is limited to mechanical keyboard recommendations
(Hutagalung, 2021)	AHP-TOPSIS	Can determine the eligibility of alternatives (customers) to get a loan, in order from the highest value to the lowest	- The combination of the two methods, in this case, is limited to the selection of eligible and unfit customers to get a loan - An algorithm or other method is needed to classify whether or not a customer is eligible to obtain a loan
(Suarnatha & Gunadi, 2021)	Profile Matching, TOPSIS	Able to display the ranking of the best lecturers with the highest to lowest performance scores	- The combination of the two methods in this case is limited to determining the performance of lecturers at Tabanan University. - Required a combination of methods and other criteria for comparison
(Akmaludin et al., 2022)	Profile Matching and MCDM- AHP	Can help to carry out the employee selection process for promotion	- Does not indicate when these two methods work together to fill in the weaknesses of each method - No reason was given why these two methods should be combined The application of the two methods, in this case, is limited to employee promotion selection

Table 10: Comparison of Previous Research Publications.

Research conducted by Primasari et al., (2018), Dhammayanti et al., (2019), Batubara & Sari (2021), Mahendra & Hartono (2021), Handayani & Wardoyo (2021), Akmaludin et al., (2022) combines the AHP method and Profile Matching method for building DSS with different parameters and cases. Where Primasari et al., (2018) used both of these methods and added the TOPSIS method to determine types of goats based on environment and financial criteria, the results of system implementation were able to determine types of goats based on experimental results that had been validated by experts so that the DSS is valid and successful in representing expert judgment, but another method is needed for weighting the dependence between criteria and sub -criteria, and research by Dhammayanti et al., (2019) combines these two methods to select candidates for certain positions in the Human Resources department from CHR Kompas Gramedia, the implementation results really help speed up HR in selecting candidates for placement in the right positions according to competence and performance, while Batubara & Sari (2021) used both methods to select students to take part in high school olympiads, expert results can help schools or teachers to accelerate the selection of students to take part in the Olympics. In addition, Akmaludin et al., (2022) combines the two methods for selecting employees for promotion, the implementation results can help carry out the process of selecting employees for promotion. The three studies by Dhammayanti et al., (2019), Batubara & Sari (2021), and Akmaludin et al., (2022) does not indicate when the two methods collaborate to fill in the weaknesses of each method in solving their respective cases and the reasons for having to use both methods. In addition, Mahendra & Hartono (2021) combines the two methods to determine the determination of student work practice which is not based on field data, so another method is needed to test the accuracy of making decisions and Handayani & Wardoyo (2021) combining the two methods of providing priority recommendations for a mechanical keyboard, the results of implementing the system can provide priority recommendations for a mechanical keyboard according to user preferences but other parameters are needed to obtain better recommendation results.

In addition, the research by Hutagalung (2021) and Suarnatha & Gunadi (2021) combines two different methods, including Hutagalung (2021) combines the AHP and TOPSIS methods to determine the feasibility of alternatives (customers) to obtain loans, the results of the implementation were able to determine the eligibility of customers to obtain loans in order from the highest value to the lowest, but another method was needed to classify whether or not customers were eligible to obtain loans, while Suarnatha & Gunadi (2021) combines the Profile Matching and TOPSIS methods to determine lecturer performance at Tabanan University, the results show that the system can display the best lecturer rankings with the highest to lowest performance values, but a combination of methods and other criteria is needed for comparison.

From the explanation of the previous research above, it can be concluded that there has been no research specifically regarding determining the best dean's list in one of the tertiary institutions using a combination of the AHP-Profile matching method and the linear interpolation model.

Conclusion

The results of the study show that the combination of the analytical hierarchy process meth od with the profile matching method, and the linear interpolation model, can help to determine the best candidate dean's list at the Dili Institute of Technology (DIT), with a consistent criterion ratio value of 0 ,030, so that it is feasible for further processing. In addition, it was also successful in determining one candidate to be the best dean's list out of 52 candidates with the highest ranking value of 5,388. This research serves as a reference for the future, to integrate with a machine learning approach to determine accuracy in supporting decision-making.

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