THE COMBINATION OF AHP AND TOPSIS METHODS IN DETERMINING THE RANKING OF RECOMMENDATIONS FOR IMPROVEMENT OF INFORMATION TECHNOLOGY SERVICES

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Abstract— To improve the quality of the information technology unit, University has to measure and improve the services based on a best-practice framework. ITIL's 3rd version was chosen to determine the service level of this unit. ITIL V3 was focused on two domains, specifically Service Operations to measure the service improvements problems and Continual Service Improvement to establish improvement continuously. The measurement showed that the maturity level of IT services in the information technology unit on the Service Operation domain was at level 3 and Continual Service Improvement was at level 2, and each gap value was 1.5 and 1, respectively. The level calculation resulted in 14 recommendations that must be applied by the information technology unit of University. The recommendations were applied by implementing a decision-making system use the combination of AHP and TOPSIS methods. AHP was needed to decide the weights of the predetermined criteria, while TOPSIS was used in the calculation to rank the available alternatives. The top to the bottom ranking of the 14 recommendations was Service Operation Processes, CSI Methods, and Techniques, Implementing CSI, Organizing for CSI, Service Management as a Practice, Service Operation Technology Consideration, CSI Technology Considerations, CSI Processes, Common Service Operation Activities, Organizing Service Operations, CSI Service Management as a Practice, CSI Principles, Service Operation Principles, and Implementing Service Operations.

Keywords:*: AHP, Multicriteria Decision Making, TOPSIS.*

Abstrak— Bentuk dari usaha peningkatan kualitas layanan teknologi informasi pada unit teknologi informasi Universitas adalah dengan melakukan pengukuran dan perbaikan layanan tersebut yang berdasarkan kerangka kerja best practice. Maka dipilihlah kerangka kerja ITIL V3 untuk mengetahui tingkat layanan pada unit ini. ITIL V3 yang digunakan berfokus pada dua domain yakni *Service Operation* yang digunakan dalam memperbaiki permasalahan dari sebuah layanan dan *Continual Service Improvement* yang digunakan dalam melakukan perbaikan secara kontinu. Setelah dilakukan pengukuran maka didapatkan bahwa tingkat kematangan layanan TI unit teknologi informasi pada domain *Service Operation* terletak di Level 3 dan *Continual Service Improvement* di level 2, sehingga masing-masing gap yakni 1,5 dan 1. Setelah melakukan perhitungan level, didapatkan 14 rekomendasi yang harus diterapkan oleh unit teknologi informasi Universitas, kemudian rekomendasi tersebut dilakukan dengan menerapkan sistem pengambilan keputusan dengan menggunakan metode AHP-TOPSIS. AHP dibutuhkan dalam menentukan bobot kriteria yang sudah ditetapkan dan untuk TOPSIS digunakan untuk melakukan atau menghitung peringkat dari alternatif yang ada. Dari perhitungan menggunakan metode AHP-TOPSIS ini didapatkan hasil perangkingan dari 14 rekomendasi tersebut yaitu *Service Operation Processes, CSI Methods and Techniques, Implementing CSI, Organising for CSI, Service Management as a Practice, Service Operation Technology Consideration, CSI Technology Considerations, CSI Processes, Common Service Operation Activities, Organising Service Operation, Service Management as a Practice CSI, CSI Principles, Service Operation Principles,* dan *Implementing Service Operation.*

Kata Kunci*:* AHP, Multicriteria Decision Making, TOPSIS.

INTRODUCTION

University is a higher education institution that has long been engaged in the field of information technology, always prioritizing services in providing facilities to obtain the information needed by implementing the utilization of information technology in the form of online information technology services.

In an organization that uses information technology support in carrying out its daily tasks, operations of information technology and systems

become a critical problem. Measurement of information technology in each company is necessary for the applied information technology to function optimally and be able to handle problems appropriately (Fitrani & Ginardi, 2019). The common problems that often recurs in information technology of University are server down issues when there are many academics accessing information technology services at the same time (Rahmatulloh & MSN, 2017). Malware virus attack which results in loss of journal publications to the lecturers (Prathivi & Vydia, 2017). Data leakage which results in decreased user confidence (Rumlus & Hartadi, 2020), Especially in the information technology services of University, long duration in handling ongoing disruptions, lack of feedback in problem-solving or communications regarding the progress of handling the user problems, as well as not achieving the annual target of information capital strategic plan. This decrease in performance is partly due to an incomplete and not periodic evaluation of service products and the lack of control over procedures, policies, processes, and changes made relating to customer services. The service processes should always be evaluated so that the service problems can be minimized and thus there will be no decline in services and quality of facilities and infrastructures provided to the students.

The above problems indicate that the information technology services of University are suboptimal and thus it raises questions about how the management process of information technology units can improve information technology services to the academic community. Therefore, the information technology unit of University wants to improve information technology services based on the ITIL V3 framework.

The information technology unit of University chose to focus on the two life-cycle domains of ITIL Version 3 consisting of Service Operations (SO) and Continual Service Improvement (CSI). Service Operation was included all daily operations of effective and efficient IT services management and how to control the stability operational of IT services and managing changes in scope, design, performance, and scale targets of operational IT services. Continual Service Improvement provides important guidance in preparing and maintaining service quality of the operational processes, design, and transition. The measurement showed that the maturity level of IT services in the information technology unit on the Service Operation domain was at level 3 and Continual Service Improvement was at level 2. To achieve the desired best practice level, the information technology unit needs to make several recommendations by the ITIL V3 framework.

Each of the two domains has 7 subdomains, so 14 recommendations will later have to be applied by the information technology unit of University. The main objective in MCDM is to serve set methodologies of aspect collection which sustain the model's development by taking the consideration of priority systems, policies, and policy assessments. The information technology unit was unable to apply 14 recommendations simultaneously so priority ranking was needed to determine which recommendation should be done first. In this research, an integrated approach was chosen, combining the AHP and the TOPSIS methods. The AHP method has accomplished the technique of MCDM as it serves structural and hierarchical method to synthesize the selection problem used to count the chosen's wights criteria (Lin et al., 2008) and the technique of TOPSIS was used to rate the alternative depends on their whole performance. MCDM is not looking for optimal solutions but helps decision-makers provide judgment and complex data involved in their problems and obverse to the suitable solutions (Roy, 1990).

Silahkan tambahkan State of the art / Literature Research

In addition, Decision-Making Systems are tools for managerial decision-making, but decision-making has a variety of different contexts (Muzakkir, 2017). DSS can be done in various many sectors, not only in universities, there are in the agricultural sector (Rupnik et al., 2019), Banking sectore (Tsagkarakis et al., 2021), Government sector (Lingga & Marbun, 2019), industrial sector (Mar-Ortiz et al., 2020), Healthcare sector (Ibrohim et al., 2020), Business sector (Octavia & Tamerlane, 2017), Construction sector (Khaqiqi & Wulandari, 2019). It is proven that multicriteria decision making can assist the decision-making process in all sectors and also focus on management based on existing perceptions according to which refers to several previous similar studies, this will later be adjusted to the method to be used.

AHP method aims to establish the priority weight of criteria, and then proceed with the calculation using the TOPSIS method. Based on these calculations, improvement priority will be obtained from the SO and CSI domains in the information technology services of the information technology unit. Therefore, the determination of the implementation phase of improvements is obtained. AHP and TOPSIS methods were chosen because the AHP method is primary tool for build the model of the decision support where the functional scale with the primary input being human insight, in which, in this matter, they are an expert in information technology service issues or someone who understands information technology service issues.

Whereas the TOPSIS method establishes the model of the decision support depend on the approach that the best alternative, it has the shortest range from the positive ideal solution and the longest range from the negative ideal solution which in this matter will give priority recommendations on which should be done first.

The decision support system to determine priority recommendations is expected to help University's information technology unit in the process of improving information technology services.

MATERIALS AND METHODS

There are 14 processes from the SO and CSI domains such as where all processes will be recommended for service improvement for the whole process by prioritizing which process is most important to do first in making service improvements that are adjusted to the criteria chosen later and prioritized through the ranking using AHP-TOPSIS method.

The criteria in this study were taken based on the merging of two journals conducting research related to technology selection from the Content Management System (CMS) using the AHP method and IT project portfolio management at Morrocan University using AHP-TOPSIS (Ahriz et al., 2018) and the model of decision for information technology selection using the integrated AHP TOPSIS-Gray: Casing content management system (Oztaysi, 2014).

Research in the journals is made as a basis because the research use AHP which focuses on the selection of technology which is quite strong about the recommendations applied because there needs to be consideration of the technology to be used as well in the journal and the AHP-TOPSIS discusses the criteria of how IT is aligned with business objectives and optimization of its resources. This study discusses several criteria used and in this study, several criteria were taken and modified to meet the research needs.

In the first journal, there are seven criteria, however, in this research, only three criteria were taken: *Budget, Duration, Reverence for the ethics, values, and the culture of the university*, because the other four criteria are not suitable to be applied in this study. On another hand, for the second journal, from the six criteria, this study only takes two criteria: *Resource optimization* and *Strategic Alignment*. These criteria were obtained from an interview with one representative of the information technology unit by selecting which criteria were needed for this study based on the two journals in the following table 1:

Tabel 1. Criteria and Alternatives

Criteria's	Criterion	Definition
C1	Resource Optimization	Criteria that consider technology and human resources owned by the organization under consideration in running a project.
C2	Strategic Alignment	Criteria that consider the alignment of IT operations with the organization and to ensure the creation of IT value for the organization
C3	Budget	Criteria that consider the total costs to be spent by stakeholders in the implementation of recommendations such as software repair costs, licensing renewal, and costs for everything that supports the implementation of recommendation
C4	Duration	Criteria used to indicate the time from the start of the recommendation planning to the recommendation implementation
C5	Reverence for the ethics, values, and culture of the university	Criteria that the ethics, culture, and behavior of the organization and the ability of the
A1	SMP	Domain Service Operation Recommendation 1
A2	SOP	Domain Service Operation Recommendation 2
A3	SOC	Domain Service Operation Recommendation 3
A4	CSOA	Domain Service Operation Recommendation 4
A5	OSO	Domain Service Operation Recommendation 5
A6	SOTC	Domain Service Operation Recommendation 6
A7	SISO	Domain Service Operation Recommendation 7
A8	SMPC	Domain CSI Recommendation 1
A9	CP	Domain CSI Recommendation 2
A10	CProc	Domain CSI Recommendation 3
A11	CMT	Domain CSI Recommendation 4
A12	OC	Domain CSI Recommendation 5
A13	CTC	Domain CSI Recommendation 6
A14	IC	Domain CSI Recommendation 7

The model proposed for the case of selecting these recommendations, consisting of the AHP and TOPSIS methods, is composed of three stages: (1) identifying the criteria to be used in the model, (2) AHP calculation, (3) evaluation of the alternative using TOPSIS and final ranking determination. In the first stage, recommendations of the alternative and criteria to be used in the assessment are recognized and a decision scale is founded. The AHP model is structured as such that the objectives are at the first tier, criteria are at the

second level and alternative recommendations are at the third tier.

RESULTS AND DISCUSSION

There are the outcomes of the count of recommendations using the AHP TOPSIS method, depend on the main concepts of the AHP TOPSIS method.

A. Criteria Identification

To ease the issue, the hierarchy of the decision is made up which consists of three main constituents: goals, criteria, and options. This is a picture of the scale of decision form used in this research, in figure 1 below:

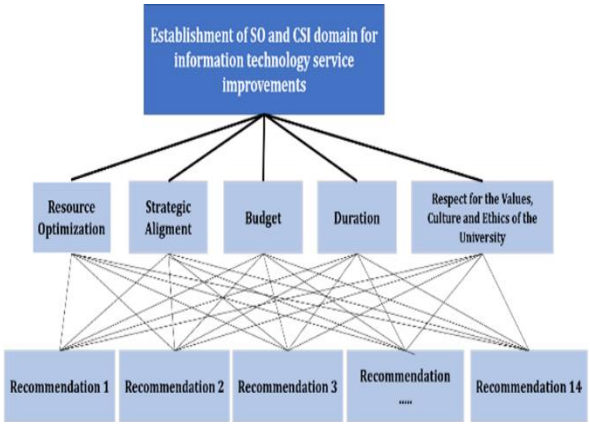

Figure 1. Recommendations Hierarchy

B. AHP-TOPSIS Calculation

After deciding the criteria, the relationship between the criteria and the criteria's weighting is done. The assessment was held by 7 respondents: Director, head of data security section, head of information imaging section, head of program integration and system development section, head of system development sub directorate, head of information system operational sub directorate, and head of the network section by conducting focus group discussions to produce raw data.

1. AHP scale values explanation

The fundamental scale used in AHP allows decision-makers to combine knowledge and impression intuitively and naturally. This scale is not sensitive to small changes in preferences of decision-makers, thereby minimizing the effects of uncertainty in evaluations. AHP is an absolute scale where people use numbers to declare how much one element dominates another with reverence to criteria (Saaty & Vargas, 2013)

2. Pairwise Comparison Matrix

Tabel 2. Pairwise Comparison Matrix

C	C1	C2	C3	C4	C5
C1	1	0.50	3.00	5.00	2.00
C2	2.00	1	3.00	9.00	2.00
C3	0.33	0.33	1	3.00	0.33
C4	0.20	0.11	0.33	1	0.14
C5	0.50	0.50	3.00	7.00	1
Total	**4.0333**	**2.4444**	**10.333**	**25**	**5.48**

Table 2 below are showing the results of the weight pairwise comparison matrix, which later this matrix will used to determine ranking in alternative calculations.

3. Matrix Normalization

After obtaining the value of the pairwise comparison matrix, the next step is to normalize the pairwise comparison matrix. The results of the comparison matrix normalization can be seen in the following table 3:

Table 3. Pairwise Comparison Matrix Normalization

C	C1	C2	C3	C4	C5	Total
C1	0.25	0.20	0.29	0.20	0.37	1.31
C2	0.50	0.41	0.29	0.36	0.37	1.92
C3	0.08	0.14	0.10	0.12	0.06	0.50
C4	0.05	0.05	0.03	0.04	0.03	0.19
C5	0.12	0.20	0.29	0.28	0.18	1.08
Total	1.00	1.00	1.00	1.00	1.00	5.00

Table 3 below is the result of the normalization of the pairwise comparison matrix, where this normalization will be used to calculate the weight of the criteria.

4. Calculate the Consistency

After normalization, the value is calculated to determine the level of consistency from filling out the questionnaire as explained in chapter 2. The percentage of AHP consistency ratio that can be accepted is when (CR) ≥ 10%. The results show a CR of 3.84%, which means that the results of this questionnaire are consistent. Table 4 shows the results of CI, CR, and percentage for consistency.

Table 4. Criteria Consistency Result

Lamda Max	C1	CR	Percentage	Result
5.1718	0.043	0.038	3.84%	Consistent

5. Criteria Weight Calculation

The next stage is calculating the weight of each criterion by dividing the sum of the normalization rows by the number of criteria the following table 5:

Table 5. Criteria Priority

Criteria		Weight Value
C2	Strategic Alignment	0.38
C1	Resource Optimization	0.26
C5	Reverence for the ethics, values, and culture of the university	0.22
C3	Budget	0.10
C4	Duration	0.04

From the calculation results, it is found that the greatest weight is on the *strategic alignment*, the purpose of this criterion is the alignment between IT operations and business goals of University because the objective of harmony between business and IT is to optimize the value that IT contributes to University by adding added value on products and services, guiding in competition, cost efficiency, and improving management effectively. It is then followed by resource optimization which includes infrastructure technology and human resources that handle whether it supports or not, then the third is Reverence for the ethics, values, and the culture of the university where the values given from the recommendations are by culture, ethics, and the ability of University itself. On the other hand, the budget and duration can adjust as long as the results obtained can align between information technology and business objectives.

6. The result of the Linkert scale average from the seven respondents

The value of the Linkert scale is obtained from the recommendation questionnaire given to seven respondents with a value scale of one to five, the average (mean) of the seven respondents is obtained, as can be seen in the following table 6:

Table 6. The average value of the linkert scale

	C1	C2	C3	C4	C5
A1	3.571428	2.8571428	1.7142857	1.857142	2.285714
A2	3.142857	2.7142857	2.1428571	2	2.142857
A3	4.142857	3.4285714	2.2857142	2.142857	2.285714
A4	2.857142	2.7142857	1.8571428	2.142857	2.714285
A5	3.285714	2.8571428	1.8571428	2	2.142857
A6	3.142857	2.8571428	1.8571428	1.857142	2.571428
A7	3.428571	2.7142857	1.5714285	1.857142	1.857142
A8	2.857142	2.7142857	1.7142857	2	2.428571
A9	3.285714	2.5714285	1.8571428	1.714285	2.285714
A10	2.857142	2.8571428	1.8571428	2	2.571428
A11	3.285714	3.2857142	2.1428571	2.142857	2.142857
A12	3.142857	2.8571428	2.1428571	2.285714	2.714285
A13	2.857142	3.1428571	1.8571428	1.857142	2.142857
A14	3.285714	3.1428571	2.2857142	1.857142	2.142857

After getting the average value of the recommendation questionnaire with a Linkert scale, then the results can multiplied by the weighted criteria that have been obtained, the results of these multiplications can be seen in the table following table 7:

Table 7. The multiplied result of mean and criteria weight

	C1	C2	C3	C4	C5
A1	0.9342995	1.0974278	0.17028069	0.07182921	0.49437425
A2	0.8221835	1.0425564	0.21285086	0.07735453	0.46347586
A3	1.0837874	1.3169133	0.22704092	0.08287986	0.49437425
A4	0.7474396	1.0425564	0.18447075	0.08287986	0.58706942
A5	0.8595555	1.0974278	0.18447075	0.07735453	0.46347586
A6	0.8221835	1.0974278	0.18447075	0.07182921	0.55617103
A7	0.8969275	1.0425564	0.15609063	0.07182921	0.40167907
A8	0.7474396	1.0425564	0.17028069	0.07735453	0.52527264
A9	0.8595555	0.9876850	0.18447075	0.06630388	0.49437425
A10	0.7474396	1.0974278	0.18447075	0.07735453	0.55617103
A11	0.8595555	1.2620419	0.21285086	0.08287986	0.46347586
A12	0.8221835	1.0974278	0.21285086	0.08840518	0.58706942
A13	0.7474396	1.2071705	0.18447075	0.07182921	0.46347586
A14	0.8595555	1.2071705	0.22704092	0.07182921	0.46347586

7. Matrix normalization on TOPSIS

Normalization of the matrix is done using the formula, as follows:

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

Note :
With i = 1,2,....,m; j = 1,2,...,n;
Rij = Normalized decision matrix
Xij = Crips value
i = Match the alternative value to the criteria get to m
j = match the alternative value to the criteria get to n

The results of the formula 1 are shown in the following table 8:

Table 8. Matrix normalization on TOPSIS

	C1	C2	C3	C4	C5
A1	0.294423	0.2616557	0.2348880	0.25	0.2622950
A2	0.259092	0.2486050	0.2936101	0.2692307	0.2459016
A3	0.341531	0.3140274	0.3131841	0.2884615	0.2622950
A4	0.235538	0.2486050	0.2544620	0.2884615	0.3114754
A5	0.270869	0.2616895	0.2544620	0.2692307	0.2459016
A6	0.259092	0.2616895	0.2544620	0.25	0.2950819
A7	0.282646	0.2486050	0.2153140	0.25	0.2131147
A8	0.235538	0.2486050	0.2348880	0.2692307	0.2786885
A9	0.270869	0.2355206	0.2544620	0.2307692	0.2622950
A10	0.235538	0.2616895	0.2544620	0.2692307	0.2950819
A11	0.270869	0.3009429	0.2936101	0.2884615	0.2459016
A12	0.259092	0.2616895	0.2936101	0.3076923	0.3114754
A13	0.235538	0.2878585	0.2544620	0.25	0.2459016
A14	0.270869	0.2878585	0.3131841	0.25	0.2459016

After getting the normalization value, the next step is to calculate the multiplication between the results of normalization with the weighted criteria can be seen in the following table 9:

Table 9. Weighted normalization

	C1	C2	C3	C4	C5
A1	0.0770223	0.1005148	0.02333152	0.00966931	0.05673147
A2	0.0677796	0.0954891	0.02916441	0.01041311	0.05318575
A3	0.0893458	0.1206178	0.03110870	0.01115690	0.05673147
A4	0.0616178	0.0954891	0.02527582	0.01115690	0.06736862
A5	0.0708605	0.1005148	0.02527582	0.01041311	0.05318575
A6	0.0677796	0.1005148	0.02527582	0.00966931	0.06382290
A7	0.0739414	0.0954891	0.02138235	0.00966917	0.04609432
A8	0.0616178	0.0954891	0.02333152	0.01041311	0.06027718
A9	0.0708605	0.0904633	0.02527582	0.00892552	0.05673147
A10	0.0616178	0.1005148	0.02527582	0.01041311	0.06382290
A11	0.0708605	0.1155921	0.02916441	0.01115690	0.05318575
A12	0.0677796	0.1005148	0.02916441	0.01190069	0.06736862
A13	0.0616178	0.1105663	0.02527582	0.00966931	0.05318575
A14	0.0708605	0.1105663	0.03110870	0.00966931	0.05318575

8. Determining (A +) and (A-)

The next stage is determining the Positive Ideal Solution (A +) or max value and the Negative Ideal Matrix (A-) or min value, the results of these values can be seen in the following table 10:

Table 10. Min and max value

	C1	C2	C3	C4	C5
MAX	0.0893458	0.1206178	0.03110870	0.01190069	0.06736862
MIN	0.0616178	0.0904633	0.02138723	0.00892552	0.04609432

9. Determining the distance between the value of each alternative with the (A+) and (A -) (*Separation Measure*)

A separation measure is an assessment of the range from an alternative to a positive ideal solution (A +), and a negative ideal solution (A -). After calculating the value of proximity related to the positive ideal solution, a ranking of alternative recommendations will obtained. The ranking

results of alternatives are presented in the following table 11:

Table 11. Alternative preference value

No.	Alternatives	Vi
1.	A1	0.440623741
2.	A2	0.26881575
3.	**A3**	**0.803067613**
4.	A4	0.370712488
5.	A5	0.337022439
6.	A6	0.416453839
7.	A7	0.261246073
8.	A8	0.281551784
9.	A9	0.280428754
10.	A10	0.373075403
11.	A11	0.546695977
12.	A12	0.465268605
13.	A13	0.394220163
14.	A14	0.497279806

Therefore, the final ranking results are:
A3>A11>A14>A12>A1>A6>A13>A10>A4>A5 >A8>A9>A2>A7

CONCLUSION

Determination of recommendations in this study with several aspects of the criteria using the AHP and TOPSIS methods went well resulting in the weighting of the criteria and accurate information. Universities can use it as an aid in decision making. The results of this calculation give the highest result, namely A3 with a value of 0.803067613. This calculation process is carried out as a basis for ranking in implementing information technology service improvements in an information technology unit using a multi-criteria approach. It can be concluded that the main priorities for the recommendations if sorted are Service Operation Processes, CSI Methods and Techniques, CSI Implementation, Organizing for CSI, Service Management as a Practice, Service Operation Technology Considerations, CSI Technology Considerations, CSI Processes, General Service Operation Activities, Service Organizing Operation, Service Management as CSI Practices, CSI Principles, Service Operation Principles, and Implementing Service Operations.

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