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Web-Based Decision Support System for Best Employee Selection in Government Institutions using Analytical Hierarchy Process (AHP) Method

[1]Dwi Atmodjo Wismono Prapto, [2]Rosen Sipahutar, [3]Mardiana Purwaningsih*
[1,2,3]Faculty of Information Technology, Perbanas Institute, Jakarta, Indonesia
*e-mail: mardiana@perbanas.id

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Abstract

Government institutions are often constrained when making decisions regarding selecting the best employees due to the unavailability of an adequate decision support system. In fact, with this system, determining the best employees can be done easily and quickly. One method that can be used is the Analytical Hierarchy Process (AHP) which supports multi-criteria selection. This web-based decision support system designed has six criteria. From the calculation results of the priority weight value for each standard, the Court Punishment criteria have the highest priority value compared to other measures. Thus the requirements for this Court Punishment will be the primary consideration in calculating the value of outstanding employees. These criteria are then used for the simulation of 10 ministry employees. The simulation results show that the designed AHP technique is proven to prepare data for high achieving employee candidates accurately.

Keywords: Decision Support System, Analytical Hierarchy Process, AHP, multi-criteria selection, best employee, e-government

1. Introduction

The government gives the award to the employee to increase the productivity and performance of civil servants in the Ministry of Education and Culture (MoEC). The award is provided as a tribute to employees who have demonstrated work performance and dedication in carrying out their duties and functions. The selection of outstanding employees within the Ministry of Education and Culture is carried out starting from the work unit level, central unit, up to the ministry level. The appraisal process for outstanding employees involves all employees. Each employee must assess a maximum of 3 employees who are considered excellent to be evaluated using the assessment format set out in MoEC No. 30 of 2018. The assigned assessment team will recapitulate the employee assessment results to determine the best employee. The government awards outstanding employees based on legality, objectivity, and openness. The current condition at the Ministry of Education and Culture is that the format for evaluating the best employees is different for each employee who has executive, supervisory, administrator, functional, and high leadership positions. Assessment of outstanding employees requires many sheets of assessment forms. The assessment team, which consists of a maximum of 7 people, takes a long time to recapitulate all employee appraisals from 406 employees.

A web-based system is needed to calculate by applying one of the Decision-Making System methods. The selection of outstanding employees is part of human resource management that needs to be carried out with the principle of justice. Decisions are made by considering the minimal impact on subjective assessments [1]. In addition, organizations often do not have scientific techniques to make decisions related to human resource activities [2], although this technique can reduce subjectivity bias. This technique also assists the assessment team in making decisions according to the provisions of ministerial regulations, being honest and fair in assessing data and facts without being influenced by personal and group opinions and considerations, and being transparent and publicly available [2].
Selecting outstanding employees is a problem that involves many components or criteria being assessed (multi-criteria) [3]–[5]. This process requires a decision support system that can accommodate these multiple criteria. The Analytical Hierarchy Process (AHP) method is one of the

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methods used to design decision support systems. The AHP method in the decision support system is used to select from many alternatives that also have multi-criteria criteria [6], [7]. The reason for choosing the AHP method in this study is that AHP can be used for all selection processes. At the same time, the determination of criteria can be changed according to the policy of the decision-maker. In addition, the AHP technique is also considered more effective [8] related to the amount of data that must be processed.

The current study related to AHP for HR activities has been carried out, but primarily for employee recruitment activities [1], [6], [9], [10]. Previous research has also used the AHP technique for evaluating employee performance [2], [11]–[13] and selecting the best employees [3]–[5]. However, using the AHP technique to assess the best employees does not provide much discussion space for government organizations. Whereas government organizations usually have many employees and tiered job levels, thus requiring a better employee appraisal technique that is faster and provides accurate data. This study proposes a web-based decision support system that involves many criteria. By taking a case study of one government department in Indonesia, the results of this study can be used as a recommendation for selecting the best employees for other organizations that have tiered criteria within their organization.

2. Research Methodology

The research was conducted in one of the Directorates at the Ministry of Education and Culture (MoEC). Primary data was collected through interviews with leaders in the directorate, through questionnaires and a semi-structured interview. Secondary data collection through literature studies, namely books, papers, textbooks, ebooks, journals, scientific papers, and other scientific sources. The collected data were analyzed using the Analytical Hierarchy Process (AHP) technique.

2.1. *Analytical Hierarchy Process* (AHP)

AHP is a method that Saaty first developed in 1980 [14]. The method takes an appropriate approach to deal with complex systems related to making decisions from several alternatives and providing options that can be considered [15]. The hierarchical model stated by Saaty is a functional hierarchical model with the primary input being human perception. Because it uses human perceptual input, this model can process both qualitative and quantitative data. AHP is seen as an effective tool to help make very complex decisions and help determine priorities in making the best decisions [16]. AHP will select a group of criteria used in deciding priorities and choose the best alternative from a group of other options. AHP requires decision-makers to issue opinions regarding the relative importance of each of the existing criteria, then indicate preferences related to the extent of criteria for each alternative [15], [17].

AHP is often used as a problem-solving method compared to other methods because it supports a hierarchical structure, as a consequence of the selected criteria, to the deepest sub-criteria [6], [7]. AHP also considers the validity up to the tolerance limit for the inconsistency of various criteria and alternatives chosen by the decision-maker and the durability of the output sensitivity analysis of decision making [18]. AHP can solve multi-objective and multi-criteria problems, whereas most other models use a single objective. Multi-criteria decision-making with AHP is based on the hierarchical structure of the issues and pairwise comparisons between factors in setting priorities using an Eigenvalue calculation framework [19].

2.2. Performance Appraisal Process

The criteria used in the process of evaluating employee performance are as follows.

1. Discipline for two years (HD2): Never (TP), Mild (R), Moderate (S), Severe (B);
2. Discipline for five years (HD5): Never (TP), Mild (R), Moderate (S), Severe (B);
3. Court punishment (HP): Never (TP), Confinement (KU), Criminal (P);
4. Work performance scores one year before (PK1): Very Good (SB), Good (BA), Enough (C), Less (K), Bad (BU);
5. Work performance scores two years before (PK2): Very Good (SB), Good (BA), Enough (C), Less (K), Bad (BU);

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6. Achievement employee scores (PB): Very good (SB), Good (BA), Enough (C), Less (K), Bad (BU).

The process approach taken in compiling the list of outstanding employees can be seen in Figure 1. The framework is explained as follows.

1. The input in this study is in the form of employee data, the value of outstanding employees, and the AHP criteria and sub-criteria. Employee data in the form of Ms. Excel is obtained from the personnel application, which is then imported into the system. The file is in the form of employee data, work performance scores, disciplinary penalties, and court penalties. The value of the outstanding employee is the value of the employee inputted into the system in the context of evaluating fellow employees who are considered excellent. Criteria and Sub-criteria are input to the system that will be used in the AHP weighting.
2. The process consists of information system design, AHP design, and database design. The design of this system uses the waterfall development methodology. Database design aims to produce a database as a data storage medium. Employee data is processed by the AHP method to generate the ranking of outstanding employees.
3. The outputs resulting from this research are outstanding employees at the work unit level.

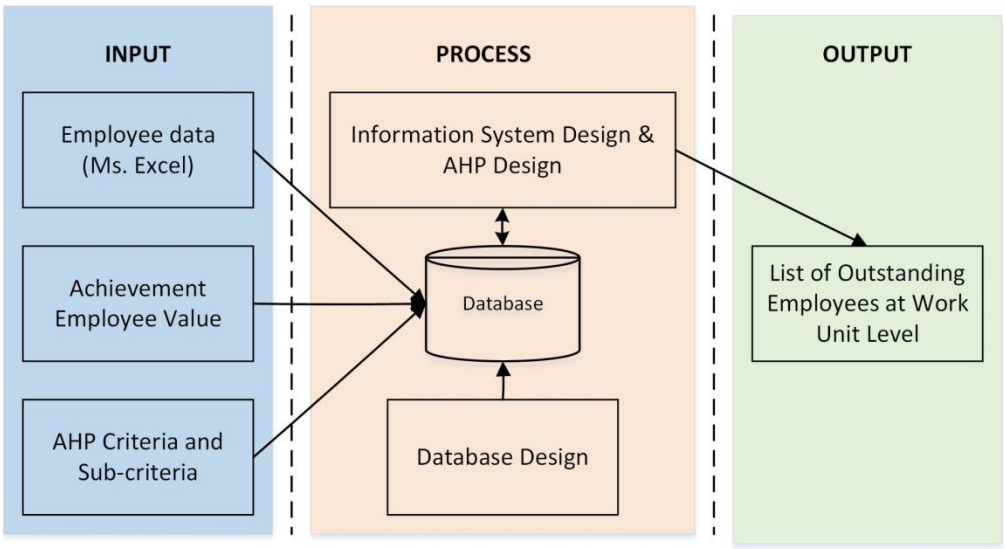

Figure 1. The Assessment Process for Outstanding Employees

3. Result and Discussion

The AHP method was chosen in the design of this decision support system because it can be used for all selection processes and guarantee fairer results based on criteria [20]. At the same time, the determination of the requirements can be made following the policy of the decision-maker.

a. The hierarchy of problems faced is a framework representing the criteria and sub-criteria in the study conducted [21]. Issues related to assessing the best employees in the Inspectorate General of the MoEC are described in several criteria and alternatives and arranged in a hierarchical structure, as shown in Figure 2.

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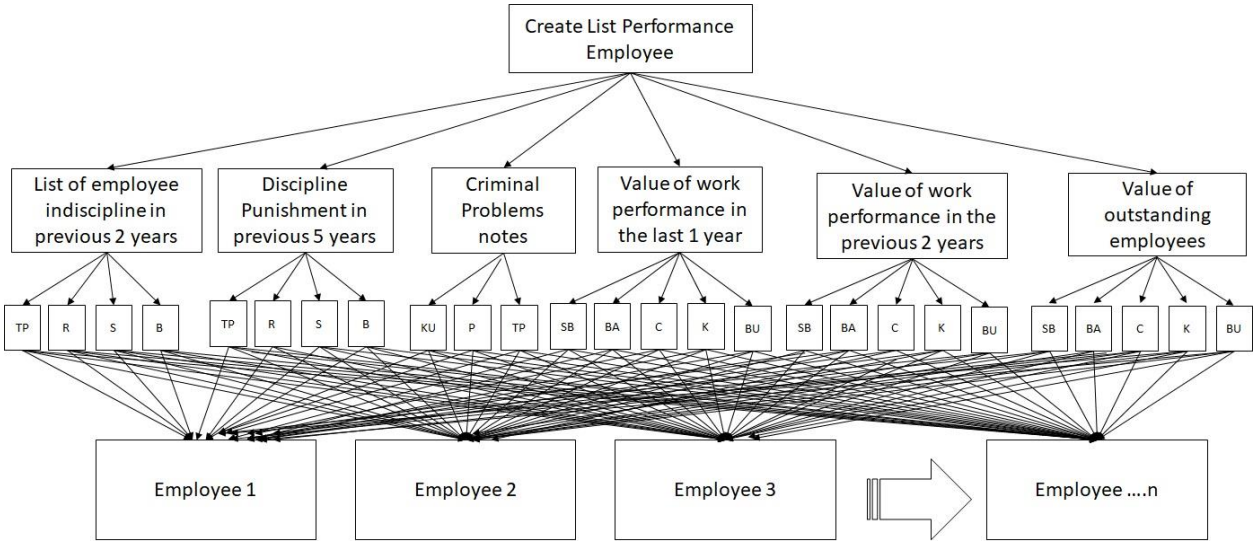

Figure 2. Hierarchy of Selecting Best Employees

b. Criteria Matrix and Priority Weight

The criterion value matrix is obtained from the element values of the pairwise comparison matrix divided by the number in each column. The priority weight is obtained from the total value of each criterion (∑**row)** divided by the number of criteria (n=6). The calculation results on Table 1 show that the court sentence criteria are the most important because they have the highest priority value compared to other measures.

Table 1. Priority Weight

Criteria	Amount (∑row)	Weight Priority (amount/n)	Priority Rank
HD2	1,69	0,28	2
HD5	0,75	0,12	3
HP	1,93	0,32	1
PK1	0,60	0,10	4
PK2	0,60	0,10	4
PB	0,44	0,07	5

From the calculation results of the priority weight value for each criterion, the Court Punishment criteria are the most important because they have the highest priority value compared to other measures. Thus, the criteria for this Court Punishment will be the primary consideration in calculating the value of outstanding employees in the Inspectorate General of the MoEC. The complete priority ranking order is presented in Table 1.

c. Paired Consistency Test Results.

1) Eigen Value

The eigenvalues are obtained by multiplying the priority weights of the criteria with the initial matrix values, then dividing the number of multiplications by the priority weights. The calculation of the Eigen Values is shown in Table 2.

Table 2. Eigen Values

Criteria	Amount	Weight Priority	Eigen Value (Amount/ Weight Priority)
HD2	1,79	0,28	6,37
HD5	0,81	0,12	6,52

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Criteria	Amount	Weight Priority	Eigen Value (Amount/ Weight Priority)
HP	2,09	0,32	6,50
PK1	0,63	0,10	6,31
PK2	0,63	0,10	6,31
PB	0,46	0,07	6,23

2) Matrix Value
The matrix value or "lamda max" is the average value of the Eigen values obtained from the previous calculation.
λ max = number of eigen values/number of criteria (n), with n=6
= (6,37+6,52+6,50+6,31+6,31+6,23)/6
= **6,37**

3) *Consistency Index* (CI)
The consistency index is calculated to ensure decision maker level of consistency when filling in the comparison value between a pair of objects.
CI = (λ max-n) / (n-1)
= (6,37-6) / (6-1) = **0,07**

4) *Consistency Ratio* (CR)
The consistency ratio value can be calculated by dividing the consistency index value by the random consistency index value.
CR = CI / IR
= 0,07 / 1,24= **0,06**

Consistency ratio index shows the consistency ratio of the pairwise comparison matrix. A comparison matrix is said to be consistent (well made) if the value of CR ≤ 0,10 [14]. The inconsistency in determining the comparison allows the AHP method not to produce the right solution. The number of alternatives and the number of factors/criteria in the AHP method will affect user consistency when providing comparative assessments between data pairs. The greater the number of other options and criteria, the more difficult it is for users to maintain consistency when setting a priority scale for comparisons between two objects. The comparison above can be consistent because it has a value of CR = 0,1.

d. Priority Sub-criteria
The results of the calculation of the sub-criteria for each criterion are shown in Table 3. The results of the oni calculation show CR <0.1, and the consistency ratio of the analysis is acceptable [14].

Table 3. Calculation of Sub-criteria

Criteria	Factor	Eigen Value	Priority weight	CR
Discipline for 2 years (HD2)	Never (TP)	4,65	0,71	0,09
	Mild (R)	4,24	0,14	
	Moderate (S)	4,05	0,10	
	Severe (B)	4,06	0,05	
Discipline for 5 years (HD5)	Never (TP)	4,22	4,22	0,04
	Mild (R)	4,17	4,17	
	Moderate (S)	4,04	4,04	
	Severe (B)	4,04	4,04	
Court punishment (HP)	Never (TP)	3,13	0,81	0,05
	Confinement (KU)	3,02	0,12	
	Criminal (P)	3,01	0,07	

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Criteria	Factor	Eigen Value	Priority weight	CR
Work performance scores one year before (PK1)	Very Good (SB)	5,33	0,47	
	Good (BA)	5,33	0,29	0,04
	Enough (C)	5,21	0,14	
	Less (K)	5,02	0,07	
	Bad (BU)	5,06	0,04	
Work performance scores two before years (PK2)	Very Good (SB)	5,33	0,47	
	Good (BA)	5,33	0,29	
	Enough (C)	5,21	0,14	0.04
	Less (K)	5,02	0,07	
	Bad (BU)	5,06	0,04	
Achievement employee scores (PB)	Very Good (SB)	5,33	0,47	
	Good (BA)	5,33	0,29	
	Enough (C)	5,21	0,14	0.04
	Less (K)	5,02	0,07	
	Bad (BU)	5,06	0,04	

The calculation result of the sub-criteria for each criterion are shown in Table 3, and because CR < 0.1, the consistency ratio of the calculation is acceptable.

e. Final Result
The priority values of the criteria and sub-criteria are stated in the result matrix, as shown in Table 4.

Table *Error! No text of specified style in document.*. **Result Matrix**

No	HD2	HD5	HP	PK1	PK2	PB
	0,28	0,12	0,32	0,10	0,10	0,07
1	TP	TP	TP	SB	SB	SB
	1,00	1,00	1,00	1,00	1,00	1,00
2	R	R	KU	BA	BA	BA
	0,20	0,47	0,15	0,60	0,60	0,60
3	S	S	P	C	C	C
	0,14	0,22	0,09	0,29	0,29	0,29
4	B	B		K	K	K
	0,07	0,10		0,15	0,15	0,15
5				BU	BU	BU
				0,07	0,07	0,07

f. Simulation
Simulation is carried out using on ten best employee candidates. The simulation results are presented in Table 5.

Table 5. Data on Proposed Best Employee Participants

No	ID	HD2	HD5	HP	PK1	PK2	PB
1	19620120198802xxxx	TP	TP	TP	87	91	92
2	19620205198802xxxx	TP	TP	P	76	89	78
3	19620626198803xxxx	TP	R	TP	66	78	87
4	19591229198003xxxx	TP	B	TP	77	77	88
5	19590521198703xxxx	TP	TP	KU	88	99	44
6	19600917198802xxxx	R	TP	TP	61	67	73
7	19631105198903xxxx	TP	TP	TP	88	90	91

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No	ID	HD2	HD5	HP	PK1	PK2	PB
8	19590528198802xxxx	TP	TP	TP	90	93	90
9	19600206198003xxxx	TP	TP	TP	85	86	60
10	19591203198802xxxx	R	TP	TP	88	87	80

Based on the criteria and sub-criteria that have been determined, each employee is assessed. The value of Best Employees candidates is presented in Table 6.

Table 6. Value of Best Employees Candidates

No	NIP	HD2	HD5	HP	PK1	PK2	PB
1	19620120198802xxxx	TP	TP	TP	BA	SB	SB
2	19620205198802xxxx	TP	TP	P	BA	BA	BA
3	19620626198803xxxx	TP	R	TP	C	BA	BA
4	19591229198003xxxx	TP	B	TP	BA	BA	BA
5	19590521198703xxxx	TP	TP	KU	BA	SB	BU
6	19600917198802xxxx	R	TP	TP	C	C	C
7	19631105198903xxxx	TP	TP	TP	BA	BA	SB
8	19590528198802xxxx	TP	TP	TP	BA	SB	BA
9	19600206198003xxxx	TP	TP	TP	BA	BA	K
10	19591203198802xxxx	R	TP	TP	BA	BA	BA

Then the final results of the assessment from Table 6 are shown in Table 7.

Table 7. Results of Outstanding Employee Values

No	NIP	HD2	HD5	HP	PK1	PK2	PB	Total	Rangking
1	19620120198802xxxx	0,28	0,12	0,32	0,06	0,10	0,07	**0,96**	**1**
2	19620205198802xxxx	0,28	0,12	0,03	0,06	0,06	0,04	0,60	9
3	19620626198803xxxx	0,28	0,06	0,32	0,03	0,06	0,04	0,79	5
4	19591229198003xxxx	0,28	0,01	0,32	0,06	0,06	0,04	0,78	6
5	19590521198703xxxx	0,28	0,12	0,05	0,06	0,10	0,01	0,62	8
6	19600917198802xxxx	0,06	0,12	0,32	0,03	0,03	0,02	0,58	10
7	19631105198903xxxx	0,28	0,12	0,32	0,06	0,06	0,07	**0,92**	**3**
8	19590528198802xxxx	0,28	0,12	0,32	0,06	0,10	0,04	**0,93**	**2**
9	19600206198003xxxx	0,28	0,12	0,32	0,06	0,06	0,01	0,86	4
10	19591203198802xxxx	0,06	0,12	0,32	0,06	0,06	0,04	0,67	7

The value in the first row HD2 column is obtained from the appropriate priority value for the HD2 sub-criteria (0.28) multiplied by the priority value of the HD2 criterion (1.00). In contrast, the total is the sum of the importance of each row. The total score is used to rank prospective participants, which will be considered in selecting participants with the three highest scores.

However, some notes in this study need to be carried out in further research. In this AHP method, the Experts involved must have knowledge and experience related to matters that will be decided using the AHP method. In other words, the results of the AHP method will vary based on the knowledge and experience of the people involved in making decisions (Expertise Judgment). In addition, the dependence of the AHP model is on its primary input. The primary input comes from the perception of an expert. And the subjectivity of the expert becomes a part that determines the results. As a result, the model becomes meaningless if the expert has the wrong perception. In general, it can be said that the limitation of this AHP is the dependence on the perception of the experts involved in the decision-making process. This dependence causes the results of the AHP method to vary for the same problem.

4. Conclusion

The simulation results show that the designed AHP technique is proven to prepare data for high achieving employee candidates accurately. With the number of employees in one work unit reaching

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hundreds of people, this technique helps speed up the recapitulation of the appraisal of outstanding employees, making it easier for the assessment team to make decisions. The AHP method is also flexible because the determination of the criteria can be changed according to the decision-maker policy. When there is a change in the criteria for outstanding employees in the future, this technique can still be used by adjusting the criteria.

One of the limitations of this study is the weakness of the AHP technique itself. The first weakness is that the respondents involved must have sufficient in-depth knowledge (expert) about AHP and the problems they face. Expert selection errors will be fatal to the results of the study. The AHP technique is also very dependent on the validity of the input data to provide valid recommendations for decision-makers. The criteria used in this study are mandatory based on a decree that applies to all units in MoEC. The main challenge of this decision-making system is to eliminate the existence of subjectivity in the input data used in calculations. This study does not discuss the differences between the AHP method and other decision support system methods. Future research can be considered using other web-based decision support system methods that can accommodate multiple criteria to compare calculation results. In addition, considering that employee data is confidential, it is necessary to research system security.

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