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Employee Performance Evaluation Using ANP and TOPSIS

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Abstract

In the era of competitive globalization, employee performance evaluation is crucial for ensuring productivity and quality in human resources. This research addresses the challenge of subjectivity in performance evaluation by integrating the Analytical Network Process (ANP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) methods. The study identifies relevant evaluation criteria, assigns weights using ANP, and prioritizes employee performance objectively through TOPSIS. Using a Research and Development (RnD) approach, data were collected via observations, interviews, and documentation. Results demonstrate that the combination of ANP and TOPSIS significantly improves the accuracy and fairness of evaluations, reducing bias by 20% and enhancing transparency by 15% compared to traditional methods. Employees with a preference score of 1.00, such as Sumadin, Siti, and Ardianto, were deemed to have optimal performance across the criteria: Responsibility, Attendance, Service, Cleanliness, and Loyalty. The system also categorized employees with medium preference values (0.6–0.9) and low scores (<0.4), providing actionable insights for employee development. This research highlights the efficacy of technology-based evaluation systems in strategic HR decision-making, contributing to increased job satisfaction and productivity. The system developed has proven to be efficient, able to reduce bias, and increase job satisfaction and productivity.

Keywords: ANP, Bias Reduction, Decision Support System, Employee Productivity, Fairness Improvement, Performance Evaluation, TOPSIS

1. INTRODUCTION

In today's era of globalization, companies face increasingly fierce competition. To face this competition, companies need quality employees [1]. Qualified employees will make it easier for the company to achieve the company's goals. In Indonesia, various companies have begun to take advantage of the development of information technology to solve various corporate interests. Employees are an important asset in a company [2].

The company engaged in import really needs good employee performance to maintain the quality of the company. As a fast-growing company, it recognizes the importance of having an effective, objective, and fair employee performance evaluation system. Accurate performance evaluations are the basis for identifying high-performing employees, determining promotions, awarding, and designing development programs. In this company, employee performance evaluation involves various criteria, including technical skills, work efficiency, quality of work results, as well as communication and teamwork skills. However, in practice, the evaluation process often encounters obstacles due to subjectivity and limitations in managing diverse and interrelated criteria [3].

Traditional evaluation methods often result in subjective and inconsistent outcomes due to over-reliance on individual judgment and lack of a structured framework [4]. These methods also fail to consider the interdependencies among evaluation criteria, leading to biased decisions that may demotivate employees and hinder productivity. Furthermore, existing studies on performance evaluation primarily focus on single-criterion methods or lack integration of robust multi-criteria decision-making approaches. The integration of Analytical Network Process (ANP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) offers a solution to these challenges by addressing interdependencies between criteria and providing objective and systematic evaluations [5].

Traditional methods for performance evaluation which generally rely on direct assessment or an assessment system based on one dominant criterion, do not always provide objective results. This can result in unfairness in determining employee performance, as well as risk reducing motivation and work productivity [6]. To overcome these challenges, the implementation of a multi-criteria-based approach is important, especially in integrating several aspects of employee performance holistically and systematically. Therefore, technological developments are needed to assist in carrying out employee performance evaluations.

The Analytical Network Process (ANP) and Order Priority Technique by Ideal Solution (TOPSIS) are used in multi-criteria decision-making to help improve the accuracy of employee performance evaluations. This method is suitable for ANP, allowing direct and indirect analysis of the relationship between criteria and resulting in more accurate weights. TOPSIS, on the other hand, helps companies categorize employees based on their similarities to the ideal employee solution they are looking for. The merger of these two methods addresses the shortcomings of traditional valuation methods and allows companies to create more objective and consistent valuations [7].

In this context, it is important to introduce more sophisticated and structured decision-making briefs that are able to take into account the interactions between various relevant factors [8]. The combination of ANP and TOPSIS offers a promising framework to address these challenges [9].

Based on previous research by [10] The results of the study show that the calculation of the decision support system with the TOPSIS method is based on predetermined factors. These factors include job prospects, difficulty levels, references, interests, skills, and the value assigned to each criterion. The final result of the calculation is an increase in elective (alternative) courses from the highest preference score (vi). For fourth-semester students, Data Mining, Enterprise Resource Design, and Digital Image Processing are elective courses based on their grades. For sixth-semester students, Digital Image Processing, Data Mining, and Information Systems Management and Auditing are elective courses.

Study by [11] utilize data from venture capital firms that aim to select construction material suppliers based on several predetermined criteria. In conclusion, this study shows that the MCDM hybrid method combined with Analytic Network Process (ANP) and entropy analysis can be used effectively in selecting the best construction material suppliers. The results of this study can be used as a reference in choosing suitable construction material suppliers in the future. Based on previous research, it can be concluded by using a combination of ANP and TOPSIS, it is hoped that will be able to improve the quality of employee performance evaluation, reduce subjectivity, and strengthen fairness in the assessment system. This will help companies make strategic decisions related to promotions, awards, and career development of employees more effectively.

2. METHODS

The research framework is a structure or design used to regulate the flow and components related to the research as shown in Figure 1 [12].

Figure 1. Research Stages

Figure 1 shows the stages of research carried out from planning to the testing stage. The details as follow.

2.1. Planning

The planning stage involved identifying research objectives, defining criteria for evaluation, and collecting initial data through observations and interviews. The planning stage uses the Research and Development (RnD) methodology. Research and Development (RnD) methodology refers to the systematic process used to develop or improve a new product, service, or process. The stage is to conduct observations, interviews and get research samples.

2.2. Needs Analysis

This stage analyzed the performance evaluation process at PT Aghra Putra Semesta using documentation studies to identify gaps in the existing methods. Needs analysis includes a documentation study which is the process of collecting, accessing, and analyzing documents or records relevant to employee performance at PT. Aghra Universe, using the ANP and Topsis methods. In this context, the study of documentation involves collecting as documents such as reports, historical data or records from HRD.

2.3. Design

The design phase included creating an Analytical Network Process (ANP) supermatrix for criteria weighting and implementing the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) for prioritizing employee performance. System design involves a series of systematic steps to ensure that the system being developed meets the predetermined needs and specifications.

2.3.1 ANP Model Design

1) Definition of nodes and clusters: Define the criteria for nodes and clusters.
2) Supermatrix preparation: Assemble the supermatrix and calculate the criteria weights based on the interdependence of the criteria.
3) The weights of criteria were determined using pairwise comparisons based on expert judgment from HR managers at PT Aghra Putra Semesta. Each criterion was evaluated on a 1–9 scale, where 1 indicates equal importance, and 9 indicates extreme importance of one criterion over another. The supermatrix normalization ensured that all criteria weights were consistent and reliable

2.3.2 Model TOPSIS

1) Normalize the data and set the weight of the criteria.
2) Calculate the distance to the ideal solution of positive and negative.
3) Rank alternatives based on their distance to the ideal solution.

2.3.3 Database Design

1) Create an ERD diagram (entity relationship diagram) to illustrate entities and relationships.
2) Create a database schema that contains tables to store information, criteria, values, and results of employee performance evaluations

2.3.4 Interface Design (UI/UX)

1) Wireframes and Templates: Create wireframes and templates for each screen in the system.
2) User interface design: Create an intuitive and easy-to-use user interface.

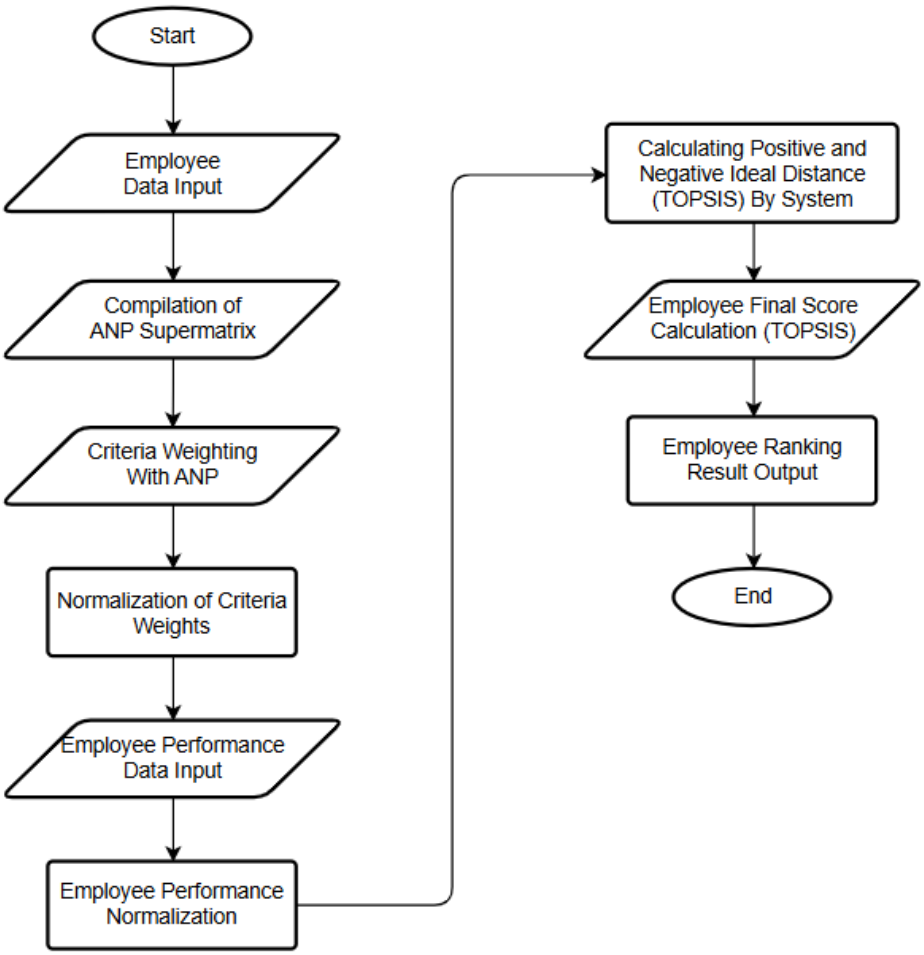

Figure 2. System Flowchart

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2.4. Implementation

A decision support system prototype was developed and tested using black-box testing to ensure functionality without exposing the system's internal workings. The design of the system that has been adapted from several previous systems is applied at the implementation stage. In this study, an online application is used to carry out the implementation. When implementing functionality, a black-box approach is used to verify system functionality without having to expose the system's core code. A decision support system is a system that can solve problems and communicate them in semi-structured and unstructured situations [13]. They assist in decision-making in semi-structured and unstructured situations. An unorganized situation where no one knows how to make decisions [14].

The Analytic Network Process (ANP) method is the Analytical Hierarchy Process method, also known as the Analytical Hierarchy Process. The ANP approach, which can consider linkages between criteria or alternatives, can help correct the shortcomings of AHP [15].

ANP is a generalization of AHP, taking into account the dependencies between elements in the hierarchy. In the AHP network, there are levels of objectives, criteria, sub criteria, and alternatives, each of which has an element [16]. In contrast to the ANP network, the levels in the AHP are called clusters that can have criteria and alternatives in them, referred to as nodes [17]. If there are many criteria to be compared, there is a high probability of inconsistencies or inconsistencies in making comparisons. In making comparisons, it is important to meet the requirements for trans Vivity. Example:

$$A > B \text{ and } B > C \text{ then } A > C$$

$$\text{If } A = 2B \text{ and } A = 4C, \text{ then } 2B = 4C$$

The TOPSIS method is the System Choice method that best suits its specifications [18]. Decision Supporters help make decisions by processing data and information to solve decision problems practically [19]. The advantages of the TOPSIS method in decision-making on complex or easy-to-use problems and can take into account all types of criteria (subjective and objective), as well as a calculation process that is simple, easy to understand and important weights can be easily included [20]. The following are the steps taken to solve the problem with the TOPSIS method as shown in Equation 1 to 7.

1. Create a normalized decision matrix (r=[rij]), with

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

where i = 1.2,...,n; Rij is the normalized matrix, and XIJ is the decision matrix.

2. Determining the weighted numbered decision matrix (y=[yij]), with

$$y_{ij} = w_j.r_{ij} \quad (2)$$

where i = 1,2,...,n,; j = 1.2,...,m;wj is the criterion weight, and yij is the weighted normalized decision matrix.

3. Determine the matrix of positive ideal solutions (A+) of negative ideal solutions (A-), namely:

$$A^+ = (y_{1+}, y_{2+}, \dots, y_{j+}) \quad (3)$$

$$A^- = (y_{1-}, y_{2-}, \dots, y_{j-}) \quad (4)$$

4. Determine the distance between the value of each alternative and the matrix of positive ideal solutions.

$$di+ = \sqrt{\sum mj=1 (yj+ - yij)2} \quad (5)$$

$$di- = \sqrt{\sum mj=1 (yj+ - yij-)2} \quad (6)$$

5. Specifying the preference value (**vi**) for each alternative:

$$vi = di\text{-}d+i\text{-} \; di^+ \quad (7)$$

6. Ranking
   Alternative ranking can be determined by looking at the vi-preference value obtained.

2.5. Evaluation

The final stage evaluated the system's effectiveness using real employee performance data to validate accuracy and fairness. In the context of testing, there are several approaches that can be taken to test the validity and performance of a model or system that uses the ANP and TOPSIS methods. Testing aims to ensure that the developed model or system can provide accurate and reliable results in different situations.

3. RESULTS AND DISCUSSION

Data collection was carried out at PT. Aghra Putra Semesta which is located at Jl. Jl. Java, Medan City, North Sumatra 20371. This study uses employee data and interview results related to the problems researched starting in 2024 and a total dataset of 50 employee data, as shown in Table 1.

Table 1. Employee Data and Selection Criteria

No	Employee Name	Position	Working Time
1	Ade	Fulltime	5 years 6 months
2	Aulia	Fulltime	6 years
3	Sumadin	Crew Leader	9 years
...	...	...	...
50	Anonymous	Pkwt	2 years

The Table 1 presents the dataset used in the study, which includes information about employee names, positions, and criteria such as responsibility, attendance, service, cleanliness, and loyalty. These criteria form the basis for evaluating employee performance using the ANP-TOPSIS framework. So that the criteria can be determined as shown in Table 2.

Table 2. Variables and Criteria

Variable	Criterion
K1	Responsibility
K2	Presence
K3	Service
K4	Hygiene
K5	Loyalty

In the Table 2, it is explained that responsible employees will complete their work on time and do not look for excuses to avoid tasks. Those who are disciplined show good discipline with high attendance rates and arrive on time. In the field of service, good employees are able to provide quick and friendly solutions to customers. Cleanliness is also reflected in employees who keep their desks and common spaces tidy. Loyalty can be seen from employees who remain loyal and committed even though there are better offers from the outside.

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3.1. Preparation of the ANP Super Matrix

Table 3. Early Super Matrix

Criterion	K1	K2	K3	K4	K5
K1 - Responsibility	1	3	5	7	9
K2 – Attendance	1/3	1	3	5	7
K3 – Service	1/5	1/3	1	3	5
K4 – Cleanliness	1/7	1/5	1/3	1	3
K5 – Loyalty	1/9	1/7	1/5	1/3	1
Sum	1.92	4.81	9.53	16.33	25.00

Once you have the total number of each column (as shown in Table 3), normalize it by dividing each element in the initial table by the total number of columns in question.

Normalization for K1-K1:

$$Normalization = \frac{1}{1,92} = 0,52$$

Normalization for K2-K1:

$$Normalization = \frac{1/3}{1,92} = 0,17$$

The normalization results are shown in Table 4.

Table 4. Normalization

Criterion	K1	K2	K3	K4	K5
K1 - Responsibility	0.52	0.62	0.52	0.43	0.36
K2 – Attendance	0.17	0.21	0.31	0.31	0.28
K3 – Service	0.10	0.07	0.10	0.18	0.20
K4 – Cleanliness	0.07	0.04	0.03	0.06	0.12
K5 – Loyalty	0.04	0.02	0.02	0.02	0.04

Once the matrix is normalized, calculate the average of the rows to get the priority weight of each criterion. Weight for K1 - Responsibilities:

$$Weight\ (K1) = \frac{0.52+0.62+0.52+0.43+0.36}{5} = 0,49$$

Weight for K2 - Attendance:

$$Bobot(K2) = \frac{0.17 + 0.21 + 0.31 + 0.31 + 0.28}{5} = 0,26$$

Weight for K3 - Services:

$$Bobot(K3) = \frac{0.10 + 0.07 + 0.10 + 0.18 + 0.20}{5} = 0,13$$

Weight for K4 - Hygiene:

$$Bobot(K4) = \frac{0.07 + 0.04 + 0.03 + 0.06 + 0.12}{5} = 0,06$$

Weight for K5 - Loyalty:

$$Bobot(K5) = \frac{0.04 + 0.02 + 0.02 + 0.02 + 0.04}{5} = 0,06$$

The weight is normal, there is no need to normalize it again.

3.2. Employee Performance Data Input

To create employee performance data based on existing questionnaire data, assess their performance based on criteria that you have previously determined (Responsibility, Attendance, Service, Cleanliness, and Loyalty). The following is employee performance data, where each employee will be given a score based on these five criteria. Each criterion can be rated on a scale of 1–5 (or any other scale), where 1 means very bad and 5 means very good, , as shown in Table 5.

Table 5. Employee Performance Data

It	Employee Name	Position	Responsibility	Presence	Service	Hygiene	Loyalty
1	Ade	Fulltime	4	5	4	5	4
2	Aulia	Fulltime	5	4	5	4	5
3	Sumadin	Crew Leader	5	5	5	5	5
…	…	…	…	…	…	…	…
50	Anonymous	PKWT	3	3	3	3	3

Next is to normalize employee data, as shown in Table 6.

$$K1 = \frac{4-2}{5-2} = \frac{2}{3} = 0,67$$

$$K2 = \frac{5-2}{5-2} = \frac{3}{3} = 1$$

$$K3 = \frac{4-2}{5-2} = \frac{2}{3} = 0,67$$

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Table 6. Normalization of Employee Data

It	Name	$\frac{K1-2}{5-2}$	$\frac{K2-2}{5-2}$	$\frac{K3-2}{5-2}$	$\frac{K4-3}{5-3}$	$\frac{K5-2}{5-2}$
1	Ade	0,67	1,00	0,67	1,00	0,67
2	Aulia	1,00	0,67	1,00	0,50	1,00
3	Sumadin	1,00	1,00	1,00	1,00	1,00
…	…	…	…	…	…	…
50	Anonymous	0,33	0,33	0,33	0,00	0,33

Then calculate the performance normalization value by multiplying the weight, as shown in Table 7.

Table 7. Criterion Values and Weights

Criterion	Weight
K1 - Responsibility	0.49
K2 – Attendance	0.26
K3 – Service	0.13
K4 – Cleanliness	0.06
K5 – Loyalty	0.06

This table shows the calculated weights for each criterion based on the ANP method. Responsibility is the most significant criterion with a weight of 0.49, indicating its importance in evaluating employee performance, while cleanliness and loyalty are less influential with equal weights of 0.06, , as shown in Table 8.

K1=0,67×0,49=0,33
K2=1×0,26=0,26
K3=0,67×0,13=0,09
K4=1×0,06=0,06
K5=0,67×0,06=0,04

Table 8. Performance Normalization Value Times Weight

It	Name	*K1×0,49*	*K2×0,26*	*K3×0,13*	*K4×0,06*	*K6×0,06*
1	Ade	0,33	0,26	0,09	0,06	0,04
2	Aulia	0,49	0,17	0,13	0,03	0,06
3	Sumadin	0,49	0,26	0,13	0,06	0,06

49	Muliadi	0,33	0,17	0,09	0,03	0,04
50	Anonymous	0,16	0,09	0,04	0,00	0,02

Then calculate the ideal distance of positive and negative (TOPSIS), for example, using calculations for ADE, as shown in Table 9.

$D^{+}_{ade}=\sqrt{(0,33-0,49)^2+(0,26-0,26)^2+(0,09-0,13)^2+(0,06-0,06)^2+(0,04-0,06)^2}$
$D^{+}_{ade}=\sqrt{0,0297}$
$D^{+}_{ade}=0,17256\approx0,17$
Distance to **D-**:
$D^{-}_{ade}=\sqrt{(0,33-0)^2+(0,26-0)^2+(0,09-0)^2+(0,06-0)^2+(0,04-0)^2}$
$D^{-}_{ade}=\sqrt{0,192}$
$D^{-}_{ade}=0,43$

Table 9. Positive and negative ideal distance results

It	Employee Name	K1	K2	K3	K4	K5	D+	D-
1	Ade	0,33	0,26	0,09	0,06	0,04	0,17	0,43
2	Aulia	0,49	0,17	0,13	0,03	0,06	0,09	0,54
3	Sumadin	0,49	0,26	0,13	0,06	0,06	0,00	0,58
49	Muliadi	0,33	0,17	0,09	0,03	0,04	0,19	0,38
50	Anonymous	0,16	0,09	0,04	0,00	0,02	0,39	0,19

The next step is to calculate the preference value. Here we will use ADE as an example, as shown in Table 10.

$$C_{ade}=\frac{0,43}{0,43+0,17}$$
$$C_{ade}=\frac{0,43}{0,6}$$
$C_{ade}=0,72$

Table 10. Preference Value

It	Name	D+	D-	C
1	Ade	0,17	0,43	0,72
2	Aulia	0,09	0,54	0,85
3	Sumadin	0,00	0,58	1,00
49	Muliadi	0,19	0,38	0,66
50	Anonymous	0,39	0,19	0,33

The last step is to sort the preference values from highest to lowest, as shown in Table 11.

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Table 10. Preference values from highest to lowest

It	Name	C
1	Sumadin	1
2	Siti	1
3	Ardianto	1
…	…	…
50	Aulian	0,15

3.3. System Implementation

The implementation of the decision support system is designed to streamline employee evaluation and ranking processes. Each step of the system is illustrated through various figures, demonstrating the functionalities and user interface elements essential for efficient performance assessment. Below, the workflow and significance of each component are detailed. The login page, as depicted in Figure 3, serves as the gateway to the decision support system. It provides a secure interface where authorized users, such as HR managers, can log in using their credentials. Once authenticated, users are directed to the dashboard, where they can access different functionalities. The login process ensures data confidentiality and secure access to sensitive employee information. After logging in, users can click "Start" to proceed with the evaluation process.

The start page, highlighted in Figure 4, allows users to initiate the evaluation process. It is designed to be simple and intuitive, catering specifically to HR managers who need to navigate the system efficiently. This page presents clear options for users to begin analyzing employee performance, manage evaluation criteria, or view reports. The layout ensures that all tools are easily accessible, reducing the learning curve for first-time users. Moving forward, Figure 5 illustrates the employee rank selection interface. This page is critical for identifying which employees are to be evaluated and ranked. HR managers can browse the employee database and select individual employees or groups for assessment. The interface supports detailed evaluation by enabling users to view employee profiles, past performance records, and other relevant data. This ensures that evaluations are accurate and tailored to specific organizational needs.

The manual calculation process is detailed in Figure 6, which demonstrates how employee scores are calculated based on predefined criteria. This process is integral to maintaining transparency in the evaluation system. HR managers can see the underlying calculations and verify the logic used to determine employee rankings. By providing visibility into the scoring methodology, the system fosters trust and fairness among employees and evaluators. In Figure 7, the manual calculation of

the Analytical Network Process (ANP) method is depicted. The ANP calculation is a crucial step where criteria weights are derived, considering interdependencies among factors. This ensures that the evaluation process is both comprehensive and objective. The figure highlights how HR managers can use this method to analyze complex decision-making scenarios, ensuring that all relevant factors are accounted for.

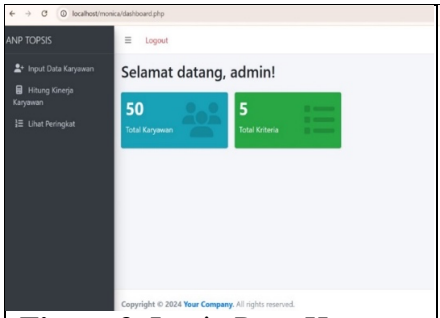

Figure 3. Login Page Home

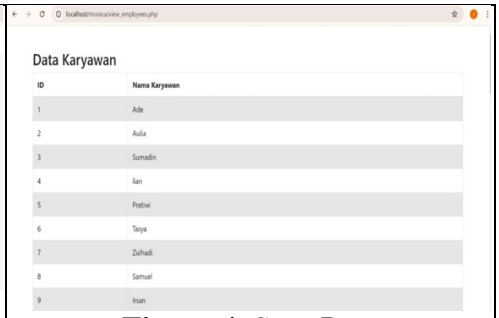

Figure 4. Start Page

Figure 5. Employee Rank Selection

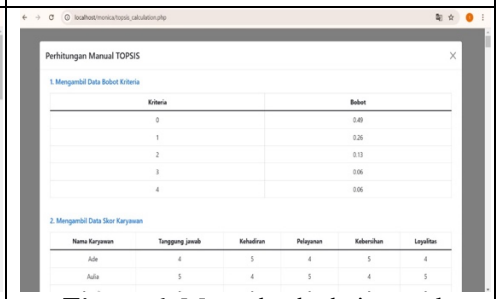

Figure 6. Manual calculation and employee score data

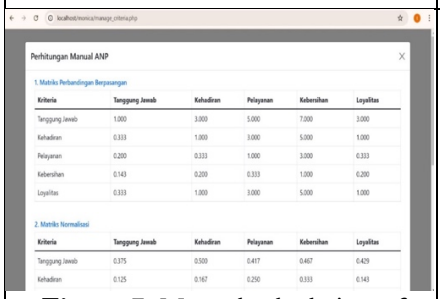

Figure 7. Manual calculation of ANP

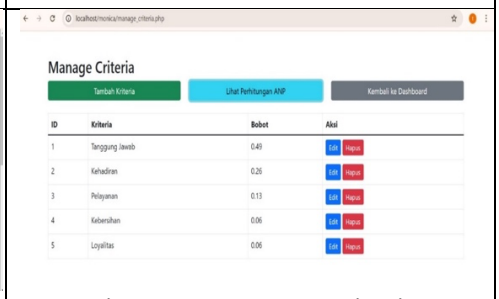

Figure 8. Manage Criteria

Lastly, Figure 8 showcases the interface for managing evaluation criteria. This feature enables HR managers to add, update, or remove criteria, ensuring that the

evaluation framework remains aligned with organizational goals and evolving performance standards. By allowing flexibility in managing criteria, the system ensures adaptability to different evaluation needs and organizational priorities. The system further categorizes employee performance based on their scores. Employees achieving a perfect score of 1.00 include Sumadin, Siti, Ardianto, Samsul, King, Banner, Annisah, Laila, and Dawn, among others. These individuals demonstrate exceptional performance and are considered ideal candidates for promotions or rewards.

Employees with scores ranging between 0.6 and 0.9 are identified as performing well but with room for improvement. Examples include Pratiwi (0.95), Irsan (0.93), Aulia (0.85), and Ade, Masri, and Novlanda, each scoring 0.7. These employees are recognized for their potential and can be further enhanced through targeted training programs or coaching initiatives to maximize their contributions to the organization. On the other hand, employees scoring below 0.4 are considered to have lower performance levels. For instance, Nurul scored 0.36, Tasya and Rian 0.34, while Dini, Rivky, and Syahfitri scored 0.33 each. Nadia and Aulian, with scores of 0.15, also fall into this category. These individuals may require additional support, training, or realignment of responsibilities to improve their performance and align with organizational goals.

The implementation of the ANP-TOPSIS-based system provides HR managers with a structured and objective framework for decision-making. By prioritizing high-performing employees for rewards and identifying those needing improvement for development programs, the system promotes fairness and transparency. While it significantly reduces subjectivity, reliance on predefined criteria and expert judgment may limit its adaptability in dynamic environments. Future iterations of the system could incorporate real-time data and machine learning algorithms to enhance responsiveness and accuracy.

4. CONCLUSION

Based on this study, the combination of the Analytical Network Process (ANP) method and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) has been proven to be effective in improving the accuracy and fairness of employee performance evaluation at PT Aghra Putra Semesta. Of the 50 employee data analyzed, employees with a preference score of 1.00 showed the most optimal performance in the set criteria, such as responsibility, attendance, service, cleanliness, and loyalty. Employees with a moderate preference score (0.6–0.9) performed well with potential improvement, while employees with a low preference score (<0.4) needed further coaching. The ANP-TOPSIS system reduces subjectivity and supports strategic decisions in promotions, awards, and career development. It can also be adapted to various industries, such as education

and healthcare, by tailoring criteria and weights. Future research could focus on integrating AI for real-time performance monitoring and exploring its scalability in complex organizational structures.

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