

A PROTOTYPE MODEL ON DEVELOPMENT OF WEB-BASED DECISION SUPPORT SYSTEM FOR EMPLOYEE PERFORMANCE ASSESSMENTS WITH SIMPLE ADDITIVE WEIGHTING METHOD

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Abstract

The manager or related supervisor performs employee performance assessments to measure the performance and competency of the company's employees. The results of employee assessments can be used to make decisions. Three problems arise in the performance assessment process for PT Tibeta Logistik Indonesia's current employees. The first is that the assessment process is carried out conventionally. So it takes longer, the assessment results can be more objective, and managers or superiors cannot monitor employee performance evaluation results. Based on the literature review, it is known that the Decision Support System is a method that performs assessments more quickly and objectively. Simple Additive Weighting (SAW) is the Decision Support System method for performance assessment. The decision support system will be implemented on a website-based system designed with a prototype model. This research produces a website-based decision support system that can contribute to companies in evaluating employee performance. Before implementation, the decision support system was tested using the User Acceptance Test (UAT) method and obtained very good average results. Then in the comparison between before and after using the system, the results of employee assessments when using the system get superior results in 3 aspects: Integration, security, and ranking.

Kata kunci: DSS, Prototipe, SAW, UAT, website.

I. INTRODUCTION

The Logistics Industry has now entered the digitalization era. Almost all parts of a company have used technology that can make it easier for companies to achieve their goals. All existing data is entered into a digital system so that all employees interested in using the data have access wherever and whenever they need it. However, the use of technology is not only for the benefit of increasing companies in running their business, but also the use of technology is essential to be applied to the field of human resources because this field is one of the main factors why companies can run well [1]. Every company in the field of human resources certainly has a standard for determining the performance of its employees, and this standard is the basis for

running every activity in a company. Decision-makers are often faced with several conflicting alternatives. The SAW method effectively makes an optimal decision in evaluating a subject with more than three criteria [2]. Some criteria are used as standards for assessing employee performance, such as thinking carefully, high curiosity, problem-solving, adaptability & agility, frequency of tardiness, silo mentality, focus on making progress, risk consideration, self-development, and delivering quality work results [3]. These predetermined criteria are the benchmark for companies in assessing their employees. PT Tibeka Logistik Indonesia, a company engaged in the logistics industry, has run its business by relying on technology. In some sections that aim to increase productivity and quality, companies have used technology, but in human

resources, they still use conventional assessments. To measure the performance assessment of human resources, it is necessary to build an employee performance assessment system [4].

A Decision Support System (DSS) can be applied to facilitate employee performance assessment [5]. DSS is a computer system that solves problems by making decisions in the organization of information and modeling results. DSS also has many methods, this case has multi-attributes, and the most appropriate method for solving multi-attribute problems is the SAW method [6]. The SAW method is a method that uses weighted sums in making decisions by looking for the weighted sum of the ratings on each alternative from each existing criterion [7]. The DSS used with the SAW method is then implemented using the website. By using the website, users can easily access information anytime and anywhere. Other research related to decision support systems shows results with ideal solutions following the criteria chosen to support decision-support by assessing the effects of the score given by the user [8]. Web-based applications can assist them in their business processes and provide recommendations according to the criteria [9]. The assessment in this research is similar to scoring, while the scoring methods are the most frequently used multiple-attribute decision-making methods because of their simplicity and efficiency [10].

Based on this background, the Design of a Decision Support System for Employee Work Evaluation Using Simple Additive Weighting was carried out to be applied to PT Tibeka Logistik Indonesia in determining employee work assessments with existing criteria. In addition to producing a decision support system that can contribute to the logistics industry in facilitating the employee assessment process through technology, this research also makes a notable difference in its design method in implementing a website-based prototype model.

II. RESEARCH METHODOLOGY

Every day, new SDLC models are introduced in the software industry, but each model has advantages and disadvantages. None of them fulfills all the requirements of the user. In the software industry, more than 50% of software has never been used, and more than 70% of software does not meet user requirements. In the research that has been done, other researchers have compared software life cycle models and tried to identify which model is helpful for which customers. So as needed, developers choose one model and try to meet customer needs [11]. This prototype model is used to develop a system in the form of a physical model that can function and be directly used by users and interact with the functions of each feature that has been made [12]. The following is a picture of the system development with the Prototype Model used in this study:

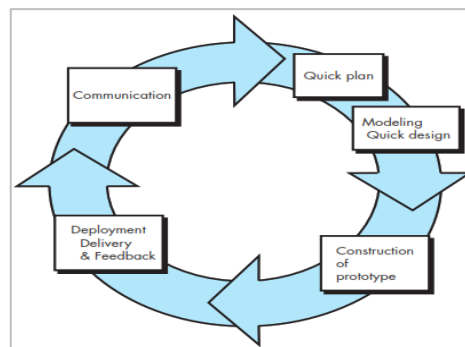


Figure 1. Prototype model

The following figure is a further explanation from figure 1 regarding the stages and processes of system development using the Prototype Model [13]:

1. *Communication.*

At this stage, communication is carried out with the manager of PT Tibeka Logistik Indonesia as the user of the decision support system designed to meet user needs. Observation and analysis are also carried out at this communication stage. The research is carried out based on the plans made, and problems are identified so that the solution approach is known. At this stage, the necessary data is also prepared to support the solution created along with the features needed in system development.

2. *Quick Plan.*

At this stage, brief planning and preparations are needed in the system development process. to determine the process of developing a decision support system with a prototype model and the SAW method implementation on the system's features.

3. *Modelling Quick Design.*

After carrying out a quick design, the next stage will be followed by a design process designed using the Unified Modeling Language (UML) diagram to describe the main functions of a system based on user needs.

4. *Construction of Prototype.*

Next is the system development stage by building a system prototype. All features created and existing functional requirements are made based on the quick plan and quick design modeling results. This stage is carried out to produce interface designs and decision support system features [14].

5. *Deployment Delivery & Feedback.*

At this final stage, all the results of system development that have been successfully made will be continued with testing to measure the functionality of the system that has been created and validated for suitability with user needs. Tests are carried out by system users and, at the same time, get feedback on the system that has been designed [15].

In a decision-support system using the Simple Additive Weighting (SAW) method, there are two attributes: the benefit attribute and the cost attribute. Both attributes have their respective goals; the benefit criteria have a calculation where the higher the value of the eating criterion, the higher the practical value in performance assessment. As for the cost attribute criteria, the higher the cost value in the assessment, the worse the evaluation [16]. The following is an overview of the process of the Simple Additive Weighting method, which can be seen in Figure 2:

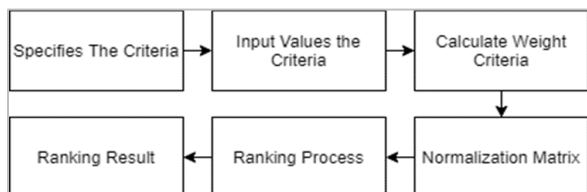


Figure 2. Simple Additive Weighting (SAW) process

- The first process is to determine the criteria used in decision-support. Based on the existing criteria, the value of each criterion will be input, then, in this process, each criterion is also weighted.
- The following process is the division of the criteria for the type of cost and the requirements for the type of benefit based on the equation adjusted for the kind of attribute benefit or costs to obtain a matrix that has been normalized R.
- The following process is matrix normalization based on criteria. The followings are the formulas and explanations for normalizing R:

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\text{Max } x_{ij}} & \text{If } j \text{ is the attribute of Benefit} \end{cases}$$

$$r_{ij} = \begin{cases} \frac{\text{Min } x_{ij}}{x_{ij}} & \text{If } j \text{ is the attribute of Cost} \end{cases}$$

Equation 1. R Normalization

- R_{ij} : Normalized performance rating.
- Max_{ij} : The maximum value of each row and column.
- Min_{ij} : The minimum value of each row and column.
- X_{ij} : Rows in columns of matrix.

In the SAW normalization formula, the value for the criterion of the benefit type is divided by the highest value in the criterion [17]. In contrast, the value for the criterion type of cost is then divided by the lowest value in the existing criteria.

- The final process of calculating using the Simple Additive Weighting method is the value obtained from the existing sorting process based on the sum of the normalized multiplication R matrices according to the weighted vector so that the highest rating can be obtained, which is selected as the best alternative as a solution [18] [19]. The following is the formula used in ranking the normalization results:

$$V_i = \sum_{j=1}^n W_j r_{ij}$$

Equation 2. SAW Formula

- V_i : The final value of the alternatives.
- W_i : Predetermined weight.
- R_{ij} : Matrix normalization.

III. RESULTS AND DISCUSSION

Based on the research methodology described in the previous section, system design and implementation of the SAW method into a decision support system were carried out.

A. Use Case Diagram

The following figure is a Use Case Diagram used to build a website-based: employee performance assessment decision-support system at PT Tibeka Logistik Indonesia:

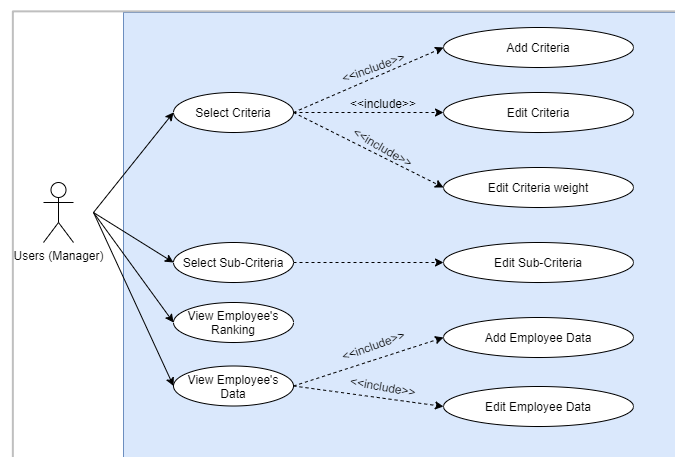


Figure 3. Use Case Diagram

Use Case Diagram explains how one user on this system carries out the performance assessment process, namely the Manager. In figure 3, there are four use cases as the system's primary function that managers can use: the sub-criteria process and the extension of these features, then the criteria function, the employee ranking function, and the employee data

management function. All of these functions can be used after the Manager logs in with the account provided; therefore, the use case diagram shown in Figure 3 does not describe login or logout because these two features are not the main features in this decision support system.

B. Simple Additive Weighting

After the use case diagram is made to describe the main functions of the user in designing a website-based decision support system, a simulation is carried out on assessing five employees using the SAW method through the system.

Table 1. SAW calculations on 5 employee's (simulation)

Criteria	Employee's name				
	FL	DJ	EC	KC	MA
Think Carefully					
High Curiosity	3	3	4	4	4
Problem Solving	3	4	2	3	4
Adaptable & Agile	4	4	3	4	3
Frequency Of Tardiness	4	3	3	3	2
Silo Mentality	2	2	4	4	3
Focus on making progress	3	2	3	3	4
Risk Consideration	4	3	3	4	4
Self-Development	3	3	3	4	3
Deliver Work Result Quality	3	3	3	4	3

The simulation in table 1 uses a sample of 5 employees, while in its implementation, it will be used to assess more than five employees. The manual method can still be used To evaluate a small number of employees and can be set directly, but if the number of employees is large, the assessment will be difficult and less objective. The simulation of the evaluation of 5 employees in this research can be a model for evaluating a larger number of employees. From the performance assessment data, there are two types of criteria, namely cost criteria and benefit criteria. From the data used in the simulation, the weight for each criterion is determined by using a rating scale starting from a scale of one to a scale of four. This scale is determined based on the assessment method carried out at PT Tibeka Logistik Indonesia, where number one is the lowest and four is the highest. In more detail, it can be written as follows: (1) very bad, (2) bad, (3) good, and (4) very good. The following are the criteria for the types of benefits with the weights of the assessment used following the performance assessment weights at PT Tibeka Logistik Indonesia:

Table 2. Value's of benefit criteria

Criteria	Value
Think Carefully	10%
High Curiosity	10%
Problem Solving	15%
Adaptable & Agile	10%
Silo Mentality	5%
Focus on Making progress	15%
risk consideration	5%

Self-development	5%
Deliver Work Result Quality	20%

There are nine criteria in table 2, which are included in the benefit criteria. If these criteria get a high score, then the employee assessment results will be better and vice versa. Whereas the criteria with the type of cost in table 3 use frequency of delinquency, which is an aspect of delays in carrying out assignments or attending activities, the higher the value of these criteria, the worse the performance assessment of the employees. The Value of the cost criteria is 5% as represent with the Frequency of tardiness. The frequency of tardiness (the independent variable) has three selected factors: habit, transportation and time management. This is linked to the academic performance (the dependent variable), establishing that these two correlates with each other in the action research.

After the weights are determined in table 2, the weights entered will be adjusted based on the performance review data provided by the PT Tibeka Logistik Indonesia manager and proceed to the following process: normalization. Based on the calculation normalization formula using the SAW method, the assessment results will be divided by the highest score for benefit-type criteria. In contrast, for cost-type criteria, the value will be divided by the lowest weight on that criterion. The following is the normalization formula used and produces the following values shown in table 3:

Table 3. Normalization

Criteria	Employee's name				
	FL	DJ	EC	KC	MA
Think Carefully					
High Curiosity	3/4=0.75	3/4=0.75	4/4=1	4/4=1	4/4=1
Problem Solving	3/4=0.75	4/4=1	2/4=0.50	3/4=0.75	4/4=1
Adaptable & Agile	4/4=1	4/4=1	3/4=0.75	4/4=1	3/4=0.75
Frequency of Tardiness	4/4=1	3/4=0.75	3/4=0.75	3/4=0.75	2/4=0.50
Silo Mentality	2/2=1	2/2=1	2/4=0.5	2/4=0.5	2/3=0.66
Focus on making progress	3/4=0.75	2/4=0.50	3/4=0.75	3/4=0.75	4/4=1
Risk Consideration	4/4=1	3/4=0.75	3/4=0.75	4/4=1	4/4=1
Self-Development	3/4=0.75	3/4=0.75	3/4=0.75	4/4=1	3/4=0.75
Deliver work result quality	3/4=0.75	3/4=0.75	3/4=0.75	4/4=1	3/4=0.75

In the normalization process that has been carried out, it will be followed by the process of ranking employees by adding and multiplying the normalized matrix R with the help of a weighted vector so that from this value, the highest value will be obtained. The best alternative can be selected as a ranking solution. From the SAW formula, the following calculations are produced in table 4:

Table 4. SAW Results Calculation

Value	Calculations
V FL	$(0.75 \times 10\%) + (0.75 \times 10\%) + (1 \times 15\%) + (1 \times 10\%) + (1 \times 5\%) + (0.75 \times 5\%) + (1 \times 15\%) + (0.75 \times 5\%) + (0.75 \times 5\%) + (0.75 \times 20\%) = \mathbf{0.8625}$
V DJ	$(0.75 \times 10\%) + (1 \times 10\%) + (1 \times 15\%) + (0.75 \times 10\%) + (1 \times 5\%) + (0.50 \times 5\%) + (0.75 \times 15\%) + (0.75 \times 5\%) + (0.75 \times 5\%) + (1 \times 20\%) = \mathbf{0.8625}$
V EC	$(1 \times 10\%) + (0.50 \times 10\%) + 0.75 \times 15\% + (0.75 \times 10\%) + (0.5 \times 5\%) + (0.75 \times 5\%) + (0.75 \times 15\%) + (0.75 \times 5\%) + (0.75 \times 5\%) + (1 \times 20\%) = \mathbf{0.7875}$
V KC	$(1 \times 10\%) + (0.75 \times 10\%) + (1 \times 15\%) + (0.75 \times 10\%) + (0.5 \times 5\%) + (0.75 \times 5\%) + (1 \times 15\%) + (1 \times 5\%) + (1 \times 5\%) + (0.75 \times 20\%) = \mathbf{0.8625}$
V MA	$(1 \times 10\%) + (1 \times 10\%) + (0.75 \times 15\%) + (0.50 \times 10\%) + (0.66 \times 5\%) + (1 \times 5\%) + (1 \times 15\%) + (0.75 \times 5\%) + (0.75 \times 5\%) + (1 \times 20\%) = \mathbf{0.8708}$

C. Interface System

After the simulation process for calculating employee rankings using the SAW method is carried out, the display of the system interface created as a medium for evaluating employees through the website is shown.:

Figure 4. Login form of DSS

To access and use the web-based employee assessment decision support system, after entering the website, the user will be asked to log in with the username and password that the Administrator created.



Figure 5. Dashboard of DSS

After successfully logging in, the user can see the dashboard display, which is equipped with several menus. On the left side is a menu tab from the system; in that tab, the user can use the features from the available menu. Based on the figure 5, there are six menu shows: Home, Admin, Employee's Data, Criteria, Sub-Criteria, and Employee's Ranking.

Data Karyawan												
No.	Nama Karyawan	Think Carefully	High Curiosity	Problem Solving	Adaptable & Agile	Frequency Of Tardiness	Silo Mentality	Focus On Making Progress	Risk Consideration	Self Development	Deliver Work Result Quali	aksi
1	FL	3	3	4	4	2	3	4	3	3	3	Ubah Hapus
2	DJ	3	4	4	3	2	2	3	3	3	4	Ubah Hapus
3	EC	4	2	3	3	4	3	3	3	3	4	Ubah Hapus
4	KC	4	3	4	3	4	3	4	4	4	3	Ubah Hapus
5	MA	4	4	3	2	3	4	4	3	3	4	Ubah Hapus

Figure 6. Employee's data (sample)

From the figure 6, it shows the employee's profile from each employee's including the assessment indicator.

Kriteria Penilaian				
No.	Nama Kriteria	Deskripsi Atribut	Total Bobot	aksi
1	Think Carefully	Benefit	10	Ubah
2	High Curiosity	Benefit	10	Ubah
3	Problem Solving	Benefit	15	Ubah
4	Adaptable & Agile	Benefit	10	Ubah
5	Frequency Of Tardiness	Cost	5	Ubah
6	Silo Mentality	Benefit	5	Ubah
7	Focus On Making Progress	Benefit	15	Ubah
8	Risk Consideration	Benefit	5	Ubah
9	Self Development	Benefit	5	Ubah
10	Deliver Work Result Quali	Benefit	20	Ubah

Total Bobot Kriteria = 100

Figure 7. Criteria's form

On figure 7, there are eight assessment criteria as a starting point for assessing employee performance by managers.

Total Bobot Kriteria = 190

Jumlah Bobot Melebihi 100 akan menyebabkan Penilaian yang Tidak Benar!

Figure 8. Error message

Furthermore, if the weight entered exceeds 100, it will display an error message "The total weight exceeding 100 will cause an incorrect assessment!" so that a performance assessment is invalid.

Sub Kriteria Penilaian				
No.	Nama Kriteria	Nilai	Keterangan	aksi
1	Think Carefully	1	Sangat Buruk	Ubah
2	Think Carefully	2	Buruk	Ubah
3	Think Carefully	3	Baik	Ubah
4	Think Carefully	4	Sangat Baik	Ubah
5	High Curiosity	1	Tidak Memahami	Ubah
6	High Curiosity	2	Kurang Memahami	Ubah
7	High Curiosity	3	Memahami	Ubah
8	High Curiosity	4	Sangat Memahami	Ubah
9	Problem Solving	1	Sangat Buruk	Ubah
10	Problem Solving	2	Buruk	Ubah
11	Problem Solving	3	Baik	Ubah
12	Problem Solving	4	Sangat Baik	Ubah
13	Adaptable & Agile	1	Tidak Kondusif	Ubah

Figure 9. Sub-criteria's form

On the sub-criteria page, the manager can change the description of each criterion entered on the criteria page based on the value of the report, where the higher the value of the sub-criteria, the more promising, while the higher the cost-type criteria, the lower the assessment.

Daftar Karyawan Terbaik		
No.	Nama Karyawan	Hasil Pehitungan SAW
1	MA	87.0833
2	FL	86.25
3	DJ	86.25
4	KC	86.25
5	EC	78.75

Figure 10. List of the best employee's

Based on the criteria and criteria values that have been entered into the employee data, if the weight is entered with a total of 100, then the employee performance ranking page can be accessed, and vice versa if the weight rating does not match the total of 100, then it cannot be accessed. In Figure 11, the simulation of employee performance ratings can be seen by the employee's name and the results of the SAW calculation, where the employee's name with the initials MA is the employee with the highest performance rating.

D. User Acceptance Test

The final stage of the process of developing a performance assessment decision support system using the simple additive weighting method is testing. The test was carried out for this research using the User Acceptance Test (UAT). After the user has finished experimenting, the user fills in the sheet for assessment with the scenario shown in table 5 below:

Table 5. Scenario Testing

No	Testing case	Result	
		Success	Failed
1	Add employee data Step to reproduce: 1. Click 'Employee Data' 2. Click 'Add Employee Data'	The addition was successful, and a	<input checked="" type="checkbox"/>

3.	Fill in the criteria with a value range of 1-4 4. Click 'Save'	'Successfully added' toast appeared.	<input checked="" type="checkbox"/>
2	Change employee data Step to reproduce: 1. Click 'Employee Data' 2. Click 'Change' 3. Fill in the criteria with a value range of 1-4 4. Click 'Save Changes'	The employee data change was successful, and the toast 'Employee Data Has Been Updated!' appears.	<input checked="" type="checkbox"/>
3	Delete employee data Step to reproduce: 1. Click 'Employee Data' tab 2. Click 'Delete'	The data was successfully deleted, and the toast 'Employee Data Deleted Successfully' appears.	<input checked="" type="checkbox"/>
4	Add employee data with a value of more than four or less than one Step to reproduce: 1. Click 'Employee Data' tab 2. Click 'Add Employee Data' 3. Fill in the criteria with a value range of >4 or <1 4. Click 'Save'	The data is not successfully added, and an error alert appears 'Value must be greater than or equal to 1' or 'Value must be less than or equal to 4.'	<input checked="" type="checkbox"/>
5	Change the scoring criteria Step to reproduce: 1. Click 'Criteria' tab 2. Click 'Change' 3. Fill in 'Criteria Name', 'Benefit', and criteria weight = <100 4. Click 'Save Changes'	The assessment criteria have been successfully changed, and the toast 'Criteria data has been updated' appears.	<input checked="" type="checkbox"/>
6	Change the scoring criteria with a total weight exceeding 100 or less than 100 Step to reproduce: 1. Click 'Criteria' tab 2. Click 'Change' 3. Fill in 'Criteria Name', 'Benefit', and criteria weight >100 or <1 4. Click 'Save Changes'	The criteria cannot be changed, and an error alert appears 'The total weight of the criteria exceeds 100' or 'The total weight of the criteria is less than 100'.	<input checked="" type="checkbox"/>
7	Change the Sub Criteria data Step to reproduce: 1. Click 'Sub Criteria' tab 2. Click 'Change' 3. Fill 'Description' 4. Click 'Save Changes'	The description of the sub-criteria has been successfully changed, and the toast 'Sub Criteria Has Been Updated' appears.	<input checked="" type="checkbox"/>
8	View employee ratings as a result of the evaluation using the SAW method: Step to reproduce: Click 'Employee Ranking'	Displays the results of employee performance assessments sorted from best to worst	<input checked="" type="checkbox"/>

From the testing scenario that has been carried out, the user fills in the UAT sheet by following the assessment weights used in the UAT as follows:

Table 6. UAT Point Description

Point	Point Description
1	Unclear/ Not Good/ Very Difficult/ Not Appropriate/ Not Fulfilled
2	Unclear/ Not Good/ Not Appropriate/ Difficult
3	Clear/ Good/ Appropriate/ Easy
4	Very Clear/ Very Good/ Very Appropriate/ Very Easy/ Fulfilled

UAT questions can be obtained using the weights provided, which will be used as a benchmark for assessing managers using the system. The results of systems UAT in table 7 shows an average score is 4, which is very good/for fulfilling the company's needs.

Table 7. User Acceptance Test (UAT)

No	Questions	Point			
		1	2	3	4
1	Does the login/logout feature work properly?				<input checked="" type="checkbox"/>
2	Is the employee performance assessment function appropriate?			<input checked="" type="checkbox"/>	

3	Are the criteria and weighting functions appropriately?				✓
4	Is the ranking result feature appropriate?				✓
5	Is the employee performance assessment system easy to use?			✓	
6	Have the objectives of the system design been met?				✓
7	Is the user helped by this system in the employee performance assessment process?				✓

E. Comparison

After the system is used by the manager of PT Tibeka Logistik Indonesia to assess the employee's performance, the comparison in employee performance assessment can be identified as follows:

Table 8. Comparison before and after using Systems

Comparison	Before	After
Integration	The employee performance assessment process is carried out conventionally using a spreadsheet application with limitations in integration, so the process of exchanging data is slow.	The employee performance assessment process can be accessed through the website.
Security	The vulnerability of the spread of sensitive data in the distribution of documents through various media such as e-mail or data transfer via hardware.	It reduces the spread of sensitive data because accessing the website requires username and password authentication.
Rank	The objective level is relatively low because the ranking results are still based on calculations by adding up the scores obtained by the employee.	Ratings based on the results of SAW calculations use presentation weights on each criterion which has a higher objectivity value than conventional methods resulting in a more accurate assessment of employee performance.

IV. CONCLUSION

After developing a decision-making system using a prototype model with the implementation of the website-based simple additive weighting method at PT Tibeka Logistik Indonesia, this research resulted in a website-based decision support system that can be used by the user (manager) in evaluating employee performance.

The test results obtained from the User Acceptance Test by running scenarios of using the system, carried out by the quality assurance manager of PT Tibeka Logistik Indonesia, produce a good assessment and follow user needs. The system that has been produced can also integrate data so that it is easily accessible anywhere and anytime. The contribution made through this research is a system designed to facilitate the assessment of employee performance objectively and quickly.

V. RECOMMENDATION

As a suggestion for further development, you should try using more than one decision-making method or combine it

using two or more methods, such as the Analytic hierarchy process (AHP) or the Promothee method. Then also, be able to focus on data security because employee assessments are usually confidential for internal purposes.

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