Determination of Annual Employee Salary Increase and Best Employee Reward Using the Fuzzy-TOPSIS Method

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Abstract - Human resources (HR) is one of the survival factors of a company, one of the aspects determining the success of a company's work is the management of HR. To improve HR performance by the needs or desires of the criteria set by the company, the company provides bonuses such as salary increases or rewards, but the company has difficulty making selections of the employee's value because of the diversity that there is still a subjective element in granting an increase in value. Besides that, the company has difficulty in determining the best employees by the wishes of the company due to the similarity in the value of employees who have the highest final value. Therefore we need a decision support system to determine the weight of the most important criteria desired by the company. This study discusses the decision support system regarding employee performance appraisal for annual salary increases and the best employees using the Fuzzy-TOPSIS method for processing data and ranking employee value data. The results of this study Employees 21 number has received the highest value of 0.656. and the UTAUT model or system test produces a T-Statistics value on Effort Expectancy (EE) of 1,316 (p-values 0.189).

Keywords - Information Systems Technology, Annual Salary Increase, Best Employees, Fuzzy-TOPSIS, UTAUT

I. INTRODUCTION

One factor that can be a company's survival is its human resources (HR). HR management of a company is one important aspect to determine work success. The company has its own way of improving the performance and welfare of these employees by providing annual salary increases but must meet certain criteria related to discipline, performance, and productivity as determined by a company [1].

The development of information technology at this time has been rapid, in the assessment of HR or employees owned by the company began to follow Information Technology such as the Decision Support System (DSS) or Decision Support System with the aim of assessments conducted by the company will be by company needs. Decision Support Systems have a variety of methods namely Fuzzy Logic, Simple Additive Weighting (SAW); Profile Matching; Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS); Analytic Hierarchy Process (AHP); Fuzzy-SAW; Fuzzy-AHP; Fuzzy-TOPSIS and others.

Decision support systems are tools that management can use to help make decisions. Some studies that use the decision support system methods include [2] using the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method; according to [1] using the Profile Matching method; according to [3] using the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method; according to [4] using the Analytic Hierarchy Process (AHP) method; according to [5] using the Simple Additive Weighting (SAW) method; according to [6] using the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method; according to [7] using the Fuzzy-TOPSIS method. Each method has advantages and disadvantages in the calculation process

This research will make a decision support system using the Fuzzy-TOPSIS method because this method is a combination that can determine alternative ranking by calculating the ideal solution of a problem and determining the weight of each criterion in the linguistic form of fuzzy and can determine the weighting of interests between criteria or variables blurred (gray) so that it will help solve the company's problems when the process of determining employee salary increases and best employee rewards using validity test with Focus Group Discussion (FGD) and model quality testing using Unified Theory of Acceptance and Use of Technology (UTAUT) .

II. METHODOLOGY

A. Research Methods

Research Systems Supporting employee assessment decisions with case studies at an educational institution or university is a type of applied research (Applied Research). The results of the research conducted can be directly implemented to solve the problems faced [8]. In this study, the method used is a quantitative method where the calculation process is carried out by the existing formula based on the method used to obtain a final value decision making it difficult for the company to determine the best employee rewards.

B. Sample Selection Method

In this study, the sample data used is employee assessment data at PT Global Metal Technology in 2018 Production and Quality control positions

C. Data Collection Methods

Data collection was carried out to obtain information and data related to this study. In collecting data and information, primary and secondary data collection methods are used.

1) Primary data collection method: Namely by collecting data directly to the data source of employee assessment, criteria/variables determining the performance appraisal of employees owned by PT Global Metal Technology. Data

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collection was carried out using the method of observation and interviews and follow-up interviews about the importance of criteria by the company.

2) Secondary data collection methods: by reading, observing and studying data from sources related to this research.

D. Methode of Analysis

At this stage the Fuzzy-TOPSIS method with linguistic variable is used for weighting variables and processing data and for determining the ranking of employees so that the company is expected to be able to determine employee salary increases and reward the best employees more objectively and by company criteria.

The concept of linguistic variables was introduced by Zadeh (1965). Linguistic variables are a way to define fuzzy sets with variables in the form of words or sentences. The role of linguistic variables is less specific than numerical or numerical variables, but the information conveyed is more informative. Linguistic variable is used to express a value that varies in an object. For example, "test scores" are linguistic variables, then the linguistic values for test score variables are, for example, "bad", "medium", "good", "very good". This is in accordance with the daily habits of humans in assessing something, for example: "The test scores obtained by Andi are very good", without giving specific Andy test scores. Each linguistic variable can be represented by fuzzy numbers. In this study the fuzzy numbers used is a triangular fuzzy number

So the result of the system is the ranking of each prospective employee based on an assessment of the criteria aspects of the company. Following are the steps in the fuzzy-TOPSIS method and equations as follows [9]:

1) Calculate the fuzzy value of each k-decision for the alternative in the evaluation of the *i* criterion that *j* is $\tilde{x}_{ij}^{k} = (a_{ij}^{k}, b_{ij}^{k}, c_{ij}^{k})$ on TABLE I and determine the fuzzy value of the importance criteria of each decision making for the jth criterion *j*, is $\tilde{w}_{ij}^{k} = (w_{j1}^{k}, w_{j2}^{k}, w_{j3}^{k})$, where $\tilde{x}_{ij}^{k}$ dan $\tilde{w}_{ij}^{k}$ are fuzzy numbers, i = 1,2,3,…, *m, j* = 1,2,3,…, *n,* dan k = 1,2,3,…, *K*. in TABLE II.

TABLE I. LINGUISTIC VARIABLE AND FUZZY NUMBER FOR ALTERNATIVE ASSESSMENT BASED ON CRITERIA EVALUATION

Linguistic Variable	Fuzzy Number
Very Poor	1,1,3
Poor	1,3,5
Fair	3,5,7
Good	5,7,9
Very Good	7,9,9

TABLE II LINGUISTIC VARIABLE AND FUZZY NUMBER FOR WEIGHT ASSESSMENT BASED ON CRITERIA INTEREST

Linguistic Variable	Fuzzy Number
Very Unimportant	1,1,3
Unimportant	1,3,5
Average	3,5,7
Important	5,7,9
Very Important	7,9,9

2) Aggregate fuzzy values of alternatives (*i*) on each criterion (*j*), as well as aggregate the importance weight of each criterion. Aggregate the fuzzy value of alternative (*i*) on each criterion (*j*). Next in Formula (1).

$$x_{ij}^{k} = (a_{ij}^{k}, b_{ij}^{k}, c_{ij}^{k}) \text{ with:}$$
$$a_{ij} = min_k\{a_{ij}^{k}\}, b_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ij}^{k}, c_{ij} = max_k\{c_{ij}^{k}\} \quad (1)$$

Aggregate the importance of each criterion. Next on the formula (2).

$$\tilde{w}_{j}^{k} = (w_{j1}^{k}, w_{j2}^{k}, w_{j3}^{k}) \text{ with:}$$
$$w_{j1} = min_k\{w_{jk1}^{k}\}, w_{j2} = \frac{1}{K}\sum_{k=1}^{K} w_{jk2}, w_{j3} = max_k\{w_{jk3}\} \quad (2)$$

3) Form a decision matrix $\widetilde{\boldsymbol{D}}$ which refers to the alternative *m* that will be evaluated against *n* criteria, form a weighting matrix of importance criteria $\widetilde{\boldsymbol{W}}$ which is defined The elements that exist in the matrix $\widetilde{\boldsymbol{D}}$ is a fuzzy value aggregation of alternative *i* to each criterion to *j*, while the elements in the matrix $\widetilde{\boldsymbol{W}}$ adalah are the aggregations of each importance criteria weight *j*, with i = 1,2,3,…, *m,* and j = 1,2,3,…, *n*.

$$\widetilde{\boldsymbol{D}} = \begin{pmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \tilde{x}_{ij} & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{pmatrix}$$
$$\widetilde{\boldsymbol{W}} = (\tilde{w}_1, \tilde{w}_2, \ldots, \tilde{w}_n) \quad (4)$$

4) Normalize the decision matrix $\widetilde{\boldsymbol{D}}$ that has been made into $\widetilde{\boldsymbol{R}}$, as well as weighting the matrix $\widetilde{\boldsymbol{R}}$ with the importance criteria ($\tilde{w}_j$) being $\widetilde{\boldsymbol{V}}$. Normalize the decision matrix $\widetilde{\boldsymbol{D}}$. Next on the formula (5)

$$\widetilde{\boldsymbol{R}} = \left[\tilde{r}_{ij}\right]_{mxn},\ i = 1,2,\ldots, \text{m};\ j = 1,2,\ldots, \text{n}, \quad (5)$$

by determining the benefit criteria in Formula (6) and the cost criteria in Formula (7).

$$r_{ij} = \left(\frac{a_{ij}}{c_j^{+}}, \frac{b_{ij}}{c_j^{+}}, \frac{c_{ij}}{c_j^{+}}\right),$$
$$c_j^{+} = max_i\{c_{ij}\}, benefit\ criteria, \quad (6)$$
$$r_{ij} = \left(\frac{a_j^{-}}{c_{ij}}, \frac{a_j^{-}}{b_{ij}}, \frac{a_j^{-}}{a_{ij}}\right),$$
$$a_j^{-} = min_i\{a_{ij}\}, cost\ criteria. \quad (7)$$

Weighting the matrix $\widetilde{\boldsymbol{R}}$ with the importance criteria ($\tilde{w}_j$) in Formula (8).

$$\widetilde{\boldsymbol{V}} = \left[\tilde{v}_{ij}\right]_{mxn},\ i = 1,2,\ldots, \text{m};\ j = 1,2,\ldots, \text{n} \quad (8)$$

with, $\tilde{v}_{ij} = \tilde{r}_{ij} \times \tilde{w}_j$.

5) Calculate fuzzy $\boldsymbol{A}^{+}$ *positive ideal solutions* and fuzzy negative ideal solutions $\boldsymbol{A}^{-}$, and calculate preference values for each alternative that can be determined using Formulas (9) and (10).

$$\boldsymbol{A}^{+} = (\tilde{v}_1^{+}, \tilde{v}_2^{+}, .., \tilde{v}_n^{+}) \quad (9)$$

with, $\tilde{v}_{ij}^{+} = max_i\{\tilde{v}_{ij3}\}$ and

$\tilde{v}_{ij3}$ = parameter ke-3 from $\tilde{v}_{ij}$, i = 1,2,…, m; j = 1,2,…, n.

$$\boldsymbol{A}^{-} = (\tilde{v}_1^{-}, \tilde{v}_2^{-}, .., \tilde{v}_n^{-}) \quad (10)$$

with, $\tilde{v}_{ij}^{+} = max_i\{\tilde{v}_{ij3}\}$ and

$\tilde{v}_{ij1}$ = parameter ke-1 from $\tilde{v}_{ij}$, i = 1,2,…, m; j = 1,2,…, n.

6) Calculate the distance between the values of each alternative with the fuzzy positive ideal solution and the fuzzy negative ideal solution, and calculate the preference value for each alternative that can be determined using Formulas (12) and (13). $\tilde{a} = (a, b, c)$ and $\tilde{b} = (a', b', c')$ into two fuzzy triangular numbers. The distance between the two numbers uses the vertex method in Formula (11).

$$d(\tilde{a}\tilde{b}) = \sqrt{\frac{1}{3}\left[(a - a')^2 + (b - b')^2 + (c - c')^2\right]} \quad (2.1)$$

$$d_i^{+} = \sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, \tilde{v}_j^{+}\right), i = 1,2,\ldots, \text{m.} \quad (12)$$

$$d_i^{-} = \sum_{j=1}^{n} d_v\left(\tilde{v}_{ij}, \tilde{v}_j^{-}\right), i = 1,2,\ldots, \text{m.} \quad (13)$$

d_i^{+} = Alternative distances with fuzzy positive ideal solutions

d_i^{+} = Alternative distances with fuzzy negative ideal solutions.

The preference value (CC_i) for each alternative can be determined by the formula (14).

$$CC_i = \frac{d_i^{-}}{(d_i^{-} + d_i^{+})}, i = 1,2,\ldots, \text{m.} \quad (14)$$

The alternative that has the highest preference value is the recommended alternative to choose

7) In scientific studies, more than one normalization technique is used, but in this study using a normalization technique that is common because this technique scales data from one range to another. Data is scaled in the range of 0 and 1 [10]. Given the corresponding value (in one column) and used as a percentage can be seen in Formula (15).

$$V_i = \frac{(V_i - V_{min})}{V_{max} - V_{min})} \times 100\% \quad (15)$$

V_i = Value to be normalized

V_{max} = The highest value of the Data Set

V_{min} = The lowest value of Data Set

8) System Testing: the test carried out using UTAUT is a quality testing system developed by Venkatesh. [11] This theory has a useful method for assessing the chances of a successful introduction of new technology in organizations. UTAUT combines the successful features of eight other leading technology acceptance theories into one test model. The eight theories that form the basis of the creation of UTAUT are Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Motivational Model (MM), Theory of Planned Behavior (TPB), Combined TAM and TPB, Model of PC Utilization (MPCU), Innovation Diffusion Theory (IDT), and Social Cognitive Theory (SCT).

III. RESULT AND DISCUSSION

A. Data Collection

The first step taken to identify the object of research is to analyze the data collected from the results of interviews and observations. In this case, the decision-makers were three division heads to evaluate 23 employees based on 11 criteria determined by the company, namely Job Knowledge, Skill, Understanding, Responsibility, Attendance, Team Work, Cooperation, Delegation, Discipline, Quality of Output and Quantity of Work.

B. Data Analysis

This research phase discusses the results of data processing analysis using the fuzzy-TOPSIS method to calculate annual salary increases and the best employees. The following is data processing using the fuzzy-TOPSIS method using 5 employee data samples.

1) Weighting evaluation and importance criteria: determine the fuzzy value of each k decision-maker for the i terhadap kriteria ke-j criterion and fuzzy value of the importance weight of the company for the j criterion. In this assessment, the fuzzy concept is used, namely linguistic variables, while for coding the importance of each criterion's importance.

TABLE III CRITERIA INTEREST WEIGHT

Code	Variable	Linguistic Variable	Attribute	Fuzzy Number
C1	Job Knowledge	Important	Benefit	5,7,9
C2	Skill	Very Important	Benefit	7,9,9
C3	Understanding	Very Important	Benefit	7,9,9
C4	Responsibility	Very Important	Benefit	7,9,9
C5	Attendance	Average	Cost	3,5,7
C6	TeamWork	Important	Benefit	5,7,9
C7	Cooperation	Very Important	Benefit	7,9,9
C8	Diligence	Important	Benefit	5,7,9
C9	Disipline	Important	Benefit	5,7,9
C10	Quality of Output	Very Important	Benefit	7,9,9
C11	Quantity of Work	Average	Cost	3,5,7

2) *Fuzzy value aggregation of employees (K)* on each criterion aggregate fuzzy values of employees (i) on each criterion (j) using the formula (1).

TABLE IV FUZZY VALUE AGGREGATION OF EMPLOYEE

Variable	Employee	Aggregation		
Job Knowledge	K3	1	3,667	9
	K5	3	7	9
	K8	3	7	9
	K13	1	6,333	9
	K21	1	6,333	9
Skill	K3	3	7	9
	K5	1	6,333	9
	K8	1	3,667	9
	K13	1	5,667	9
	K21	1	5	9
Understanding	K3	1	3	5
	K5	1	3,667	7
	K8	3	5,667	9

Variable	Employee	Aggregation		
	K13	3	6,333	9
	K21	5	7	9
Responsibility	K3	3	7	9
	K5	1	5	9
	K8	1	6,333	9
	K13	1	7	9
	K21	1	5,667	9
Attendance	K3	1	4,333	9
	K5	3	7,667	9
	K8	1	4,333	7
	K13	1	6,333	9
	K21	3	7	9
TeamWork	K3	1	5,667	9
	K5	5	8,333	9
	K8	1	5,667	9
	K13	3	6,333	9
	K21	1	6,333	9
Cooperation	K3	1	5	9
	K5	1	5	9
	K8	3	5,667	9
	K13	1	6,333	9
	K21	3	5,667	9
Diligence	K3	1	4,333	9
	K5	3	7	9
	K8	1	5,667	9
	K13	1	3,667	7
	K21	3	7,667	9
Disipline	K3	7	9	9
	K5	5	7,667	9
	K8	1	4,333	9
	K13	1	3	5
	K21	1	5,667	9
Quality of Output	K3	1	3	7
	K5	5	7,667	9
	K8	1	4,333	9
	K13	3	7	9
	K21	5	8,333	9
Quantity of Work	K3	1	3	5
	K5	1	3,667	9
	K8	1	1	3
	K13	1	7	9
	K21	1	5	9

C. *Research Testing*

The test results use the UTAUT method for data transformation from qualitative (ordinal scale) to quantitative (interval scale), using the MSI (Method of Successive Interval) method. The technique used in the outliers test is the PLS Algorithm method. With a total sample of 24 data, in the bootstrapping procedure, the researcher used a sample of 24 data, two-tailed test and basic bootstrapping with the results can be seen in Fig.1.

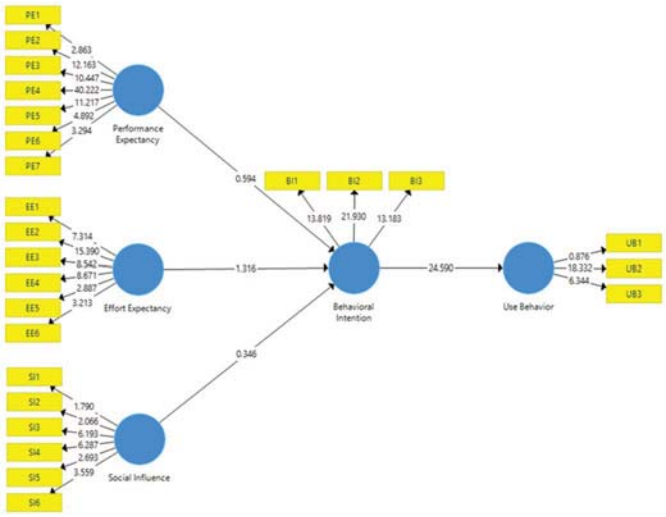

Fig. 1 Inner Model After Bootstrapping

In testing the hypothesis in this study the results of total effects are shown after the bootstrapping mechanism. The results can be seen in TABLE V

TABLE V TOTAL EFFECTS FOR HYPOTHESES TEST

	Original Sample	Sample Mean	STDEV	T-Statistics	P-Values
BI→UB	0.868	0.881	0.035	24.590	0.000
EE→BI	0.557	0.532	0.423	1.316	0.189
EE→UB	0.483	0.470	0.376	1.286	0.199
PE→BI	0.211	0.218	0.355	0.594	0.553
PE→UB	0.183	0.193	0.314	0.584	0.559
SI→BI	0.096	0.155	0.278	0.346	0.729
SI→UB	0.084	0.135	0.247	0.339	0.735

Based on the value of the total effects presented in TABLE V , it can be said that:

1) H1: Performance expectancy (PE) positively influences the level of intention (BI) of employees to use decision support systems as a means to share knowledge and gain knowledge. (**H1 is rejected**, p-values [0.553]> 0.05).

2) H2: Effort expectancy (EE) positively influences the intention (BI) of employees to use decision support systems as a means to share knowledge and gain knowledge. (**H2 is rejected**, p-values [0.189]> 0.05).

3) H3*: Social influence (SI)* positively influences the intention (BI) of employees to use decision support systems as a means to share knowledge and gain knowledge. (**H3 is rejected**, p-values [0.729]> 0.05).

4) H4: Behavioral intention positively influences the actual level of use or use behavior of decision support systems as a means of sharing knowledge and gaining knowledge. (**H4 is accepted**, p-values are significant at [0.000] <0.01 and <0.05 at once).

IV. CONCLUSION

The conclusions generated based on this study are as follows:

1) The fuzzy-TOPSIS method is a Multi-Criteria Decision Maker (MCDM) decision-making method. This method can be used to choose the best employee from several alternative employee assessments given based on criteria determined by the company. Based on the case study in this study, 21st employee (K21) received the highest score of 0.656 from 23 employees, obtained the highest rank and received a salary increase of Rp 100,000.
2) Based on the results of the UTAUT hypothesis test obtained there is one hypothesis that is accepted. The first condition is Effort Expectancy (EE) has a positive and significant effect on Behavioral Intention (BI) with a T-Statistics value of 1,316 (p-values 0.189). By mediating BI variables, it turns out that EE also has a positive and significant indirect effect on the Use Behavior (UB) variable, it is indicated by the T-Statistics value of 1,286 (p-values 0.199). In the second condition, Performance Expectancy (PE) and Social Influence (SI) do not have a direct influence on Behavioral Intention (BI). Furthermore, PE and SI variables also do not have any effect on the mechanism of the formation of Use Behavior (UB). Thus it can be concluded that employees who work at PT Global Metal Technology companies use decision support systems to reduce their effort and time in doing their jobs. In other words, to simplify and speed up their work employees will use the decision support system made in this study because it is easy for use.

ACKNOWLEDGMENT

We thank those who have helped so that this paper can be completed. In particular, we thank the Faculty of Information Technology, Budi Luhur University, for providing their knowledge and PT. Global Metal Technology which has provided a place of research.

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