

# Decision Tree Model for Measurement of Teacher Performance Optimality in Determining Giving Merit Pay Compensation

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## Abstract

Jealousy is very influential on the process of teaching and learning for teachers caused by the equal rights of compensation for all teachers without an adjustment to the assessment of teacher performance. To overcome the jealousy educational institutions today provide compensation in the form of merit so that problems can be overcome jealousy by giving the compensation of merit pay based on performance of each teacher. In determining the compensation of merit pay given to teachers, as indicators in assessing the performance appraisal of teachers as educators and teachers are pedagogic competence, social competence, competence and professional competence personality. To get a better solution optimality in the measurement of teacher performance in the determination of the compensation of merit pay, in this study the researcher offers solutions using decision tree models.

**Keywords:** *Teacher,, Performance of teachers, Compensation, Merit pay, Decision tree*

## Preliminary

Classification is a classic problem in machine learning and data mining to predict a value in a set of data<sup>1</sup>. Classification itself is a process of finding a collection of patterns or functions that describe and separate one class of data from one another to state that the object belongs to a specified category. One popular classification method is the decision tree method or decision tree. This method is popular because it is able to classify and shows the relationship between attributes. Various kinds of algorithms that can build a decision tree one of which is C45<sup>2</sup>.

In the world of education today has applied professional work productivity to overcome social jealousy among teachers in obtaining compensation by using compensation methods in the form of merit pay which is able to produce differences in compensation for teachers based on the

performance and loyalty of each individual teacher. Based on law number 142 of 2005, in determining the merit pay given to teachers, which is an indicator of assessment in assessing the performance of teachers as educators and teachers is pedagogic competence, social competence, personality competence and professional competence<sup>4</sup>. In this study teachers and lecturers have different competencies, according to the Decree of the House of Representatives of the Republic of Indonesia and the President, Law of the Republic of Indonesia No. 14 of 2005, concerning Teachers and Lecturers. To overcome this problem, in this study, researchers offered a Decision Tree model to optimize teacher performance in determining merit pay compensation.

## Decision Tree

Decision trees are one of the most popular classification methods because they are easy to interpret by humans. Decision trees are prediction models using tree structures or hierarchical structures. The concept of a decision tree is to convert data into decision trees and decision rules<sup>3</sup>. The main benefit of using decision trees is their ability to lower down complex decision making processes to be simpler so that decision makers will better interpret the solution to the problem. Decision trees are also useful for exploring data, finding hidden relationships between a number of potential input variables with a target variable. Decision trees combine data exploration and modeling, so it is very good as a first step in the modeling process even when used as the final model of several other techniques. The concept of a decision tree converts data into a decision tree and rules of decision (rule) 6. Can be seen in the display of image 1. as below:

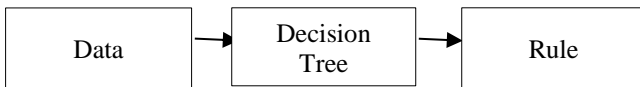


Figure1. Concept Decision Tree

The basic concept of the decision tree (decision tree) can be seen in table 1. rules as follows:

Table No. 1: Basic Concepts of Decision Tree

No.	Image	Keterangan
1.		Decision
2.		Chance
3.		fork
4.		Alternative Decisions
5.		Alternative Possibilities that occur

In the decision tree there are 3 types of nodes, namely:

- Root Node, is the top node, there is no input on this node and can have no output or more than one output.
- Internal Node, is a branching node. At this node there is one input and has a minimum output of two.
- Leaf Node or terminal node, is the end node. At this node there is one input and no output At the decision tree of each node and mark the class label. Nodes that are not end nodes consist of roots and internal nodes consisting of attribute test conditions in some records that have different characteristics. Root knots and internal vertices are marked with an oval shape and leaf nodes are marked with a rectangular shape<sup>3</sup>.

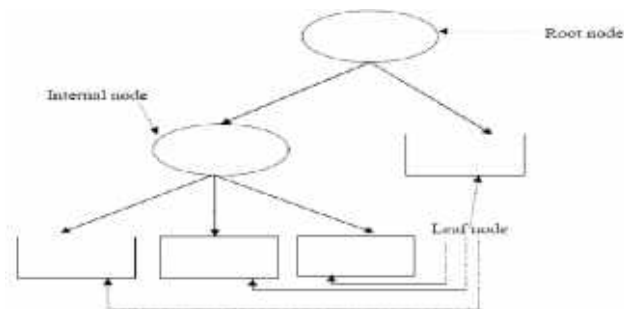


Figure 2. Decision Tree for intrusion classification problems

### Merit Pay compensation

Compensation is giving rewards to employees with financial payments as remuneration for work carried out and as motivators for the implementation of activities in the future<sup>7</sup>, including this compensation are wages, salaries, incentives, commissions, etc. that attract employees to work. Merit pay is a reward (reward) that is associated with services or work performance (performance) someone and the benefits that have been given by employees to the organization. In simple terms, the concept of merit pay is a payment system that associates rewards with one's work performance. The implication of merit pay is that someone who has a good performance, then he will get a higher reward, and vice versa. This means that the higher the performance achieved by employees will be the higher the increase in benefits<sup>8</sup>. The concept of merit pay has been implemented in various ways, but all service payment programs have two characteristics. First, a portion of employee service payments is based on the performance that has been rated in the previous period. Second, the increase in services provided in one evaluation period enters the basic salary for the upcoming evaluation period.

### RESEARCH METHODS

#### Research design

This study builds a design model outlined in the form of flow charts as follows:

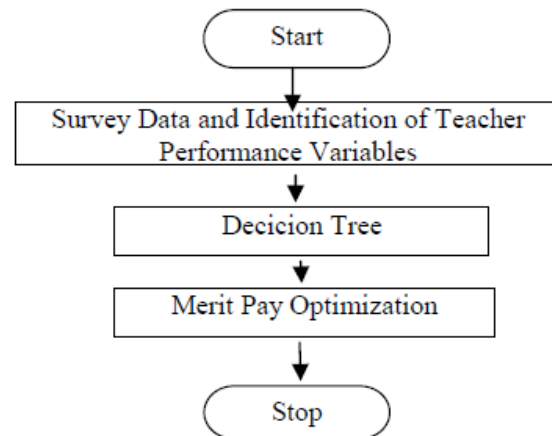


Figure 3. Diagram Model Design

#### Variable identification

Variables that will be the determinant in determining the amount of compensation given to subject teachers are variables of pedagogic competence, personality competence, social competence and professional competence<sup>5</sup>. a. Pedagogic Competence, consisting of:

- Know the characteristics of students
- Mastering learning theory and educational learning principles
- Able to develop curriculum
- Educational learning activities
- Understand and develop the potential of students
- Communication with students
- Assessment and evaluation of learning

b. Personality Competence

- Acting in accordance with religious, legal, social and national cultural norms
- Mature and exemplary personal shows
- Demonstrate work ethic, high responsibility to be proud of being a teacher and selfconfidence.

c. Social Competence

- Be inclusive, act objectively, and not discriminate because of consideration of gender, religion, race, physical condition, family background, and socio-economic status.
- Communication with fellow teachers, education staff, parents, students, and the community

d. Professional Competence

- Mastering material, structure, concepts and scientific thought patterns that support subjects
- Develop professionalism through reflective action

The total number of indicators above is 14 indicators, where the value of each indicator is 1-4 which is calculated based on Permenneqpan & RB no. 16 of 2009

**Data collection technique**

The technique used by researchers in collecting data needed is by method / technique:

- Using various kinds of literature relating to teacher performance in the decision tree model.
- Conduct observations by asking questions to informants who know things related to the topic of discussion.
- Documentation Study, namely by collecting supporting data obtained directly at the Education, Youth and Sports Service of Deli Serdang Regency.

Decision Tree Building a top-down decision tree, starting with which attribute questions should first be checked and placed in root2. This question is answered by evaluating all existing attributes using the statistical measure of the gain ratio to measure the effectiveness of an attribute in classifying a collection sample data. Classification can be seen as a mapping of a group of sets of attributes from a particular class. Decision Tree classifies the data given using the value of attributes based on the value of pedagogic

competence, personality competence, social competence and professional competence.

**a. Entropy**

To calculate the gain ratio, the entropy value must first be known. Entropy is a parameter to measure the heterogeneity (diversity) of a collection of data samples. If the collection of data samples is increasingly heterogeneous, then the entropy value is getting bigger. Mathematically, entropy is formulated as follows2:

$$Entropy (S) = \sum_{i=1}^c - P_i \log_2 P_i$$

where c is the number of values in the target attribute (number of classification classes). While pi states the number of samples for class i.

**a. Gain ratio**

After the entropy value is obtained from a collection of data samples, we can measure the effectiveness of an attribute in classifying data. This measure of effectiveness is called the gain ratio. Gain ratio is calculated based on split information which is

formulated as follows2:

$$SplitInformation(S, A) = \sum_{i=1}^c - \frac{|S_i|}{|S|} \log_2 \frac{|S_i|}{|S|}$$

where S states the set of data samples and S1 to Sc states the sub-set of data samples divided by the number of variation values in attribute A. Furthermore, the gain ratio is formulated as follows2:

$$Gain(S, A) = \frac{Entropy(S) - \sum_{V \in \{values(A)\}} \frac{S_v}{S} Entropy(S_v)}{SplitInformation(S, A)}$$

where V represents a possible value for attribute A, Values (A) is a set of possible values for attributes A. Sv is the number of samples for the value of v, and S is the sum of all data samples. Entropy (Sv) is entropy for samples that have a value of v.

### Merit Pay Optimization

To do this stage, first determined the multiplier for each Linguistic Value, for example as in table 2 below.

Table 2. Linguistic Values

Linguistic	Cost
Less	Rp. 750.000
Medium	Rp. 1,000.000
Enough	Rp. 1,500.000
Good	Rp. 2,000.000
Very Good	Rp. 3,000.000

Then to get the amount of merit pay compensation received by each teacher is to multiply the decision tree value (Z) at the cost according to the teacher's linguistic value ( $MP = Z / 100 * Cost$ )

### RESULTS AND DISCUSSION

The decision tree process is carried out in four competencies, namely pedagogic competence, personality competence, social competence, and professional competence.

This data can be seen as in table 3, as follows:

Table 3. Display of Teacher Competency Data

Pedagogik	Kepribadian	Sosial	Profesional
78.57	91.67	100	75
82.14	58.33	100	50
92.86	91.67	75	100
75.00	100.00	100	100
89.29	83.33	100	87.5
85.71	83.33	75	87.5
82.14	83.33	87.5	75
82.14	100.00	100	87.5
100.00	100.00	87.5	87.5
78.57	100.00	100	100
70.57	75.00	75	75
92.86	91.67	87.5	75
82.14	83.33	75	75
85.71	91.67	100	75
82.14	91.67	75	87.5
85.71	75.00	100	75
82.14	75.00	75	75

From table 3 if seen in this case the Teacher Job Appraiser (PKG) learning becomes Permenegpan & RB No. 16/2009 can be seen in table 4 as follows:

Table 4. Performance Value Conversions

**Table 4. Performance Value Conversions**

51-56	➔	91 - 100	Very Good = Amat Baik	125%
42-50		76 -90	Good= Baik	100%
34 - 41		61 - 75	Enough = Cukup	75%
28 - 33		51 - 60	Medium= sedang	50%
≤ 27		≤ 50	Less= Kurang	25%

From table 3 and table 4 the display of the decision tree results can be seen as in table 5 as follows:

**Table 5.** Criteria set

id teacher	Value Pedagogic	Value Personality	Value Social	Value Profesional	Average	Pedagogic	Personal ity	Social	Professional	Inform asi
1	78.57	91.67	100	75	86.31	Baik	Amat Baik	Amat Baik	Cukup	Yes
2	82.14	58.33	100	50	72.62	Baik	Kurang	Amat Baik	Kurang	No
3	92.86	91.67	75	100	89.88	Amat Baik	Amat Baik	Cukup	Amat Baik	Yes
4	75	100	100	100	93.75	Cukup	Amat Baik	Amat Baik	Amat Baik	Yes
5	89.29	83.33	100	87.5	90.03	Baik	Baik	Amat Baik	Baik	Yes
6	85.71	83.33	75	87.5	82.89	Baik	Baik	Cukup	Baik	Yes
7	82.14	83.33	87.5	75	81.99	Baik	Baik	Baik	Cukup	Yes
8	82.14	100	100	87.5	92.41	Baik	Amat Baik	Amat Baik	Baik	Yes
9	100	100	87.5	87.5	93.75	Amat Baik	Amat Baik	Baik	Baik	Yes
10	100	100	100	100	100	Amat Baik	Amat Baik	Amat Baik	Amat Baik	Yes
11	78.57	75	75	75	75.89	Baik	Cukup	Cukup	Cukup	Yes
12	92.86	91.67	87.5	75	86.76	Amat Baik	Amat Baik	Baik	Cukup	Yes
13	82.14	83.33	75	75	78.87	Baik	Baik	Cukup	Cukup	Yes
14	85.71	91.67	100	75	88.1	Baik	Amat Baik	Amat Baik	Cukup	Yes
15	82.14	91.67	75	87.5	84.08	Baik	Amat Baik	Cukup	Baik	Yes
16	85.71	75	100	75	83.93	Baik	Cukup	Amat Baik	Cukup	Yes
17	82.14	75	75	75	76.79	Baik	Cukup	Cukup	Cukup	Yes

From the above view can be formulated as follows:

$$Gain(S, A) = \frac{Entropy(S) - \sum_{V \in \text{values}(A)} \frac{S_i}{S} Entropy(S_v)}{SplitInformation(S, A)}$$

$$Entropy \text{ total} = (-16/17) * \log_2(16/17) - (1/17) * \log_2(1/17) = 0.3228$$

## 1. Pedagogic

<p>a. Very Good</p> $Entropy(S)_{AmatBaik} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (4/4) * LOG_2(4/4) - (0/4) * LOG_2(0/4)$ $= (1) * LOG_2(1) - (0) * LOG_2(0)$ $= 0$	<p>b. Good</p> $Entropy(S)_{Baik} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (11/12) * LOG_2(11/12) - (1/12) * LOG_2(1/12)$ $= (0,9166667) * LOG_2(0,9166667) - (8,333334E-02) * LOG_2(8,333334E-02)$ $= 0,4138$
<p>c. Enough</p> $Entropy(S)_{cukup} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (1/1) * LOG_2(1/1) - (0/1) * LOG_2(0/1)$ $= (1) * LOG_2(1) - (0) * LOG_2(0)$ $= 0$	<p>d. Gain</p> $Gain(S, A) = \frac{Entropy(S) - \sum_{V \in Values(A)} \frac{S_i}{S} Entropy(S_v)}{SplitInformation(S, A)}$ $= (4/17 * 0) - (12/17 * 0,4138) - (1/17 * 0)$ $= (0,3228 - 0,292094)$ $= 0,030706$

## 2. Personality

<p>a. Very Good</p> $Entropy(S)_{AmatBaik} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (9/9) * LOG_2(9/9) - (0/9) * LOG_2(0/9)$ $= (1) * LOG_2(1) - (0) * LOG_2(0)$ $= 0$	<p>b. Good</p> $Entropy(S)_{Baik} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (4/4) * LOG_2(4/4) - (0/4) * LOG_2(0/4)$ $= (1) * LOG_2(1) - (0) * LOG_2(0)$ $= 0$
<p>c. Enough</p> $Entropy(S)_{Cukup} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (3/3) * LOG_2(3/3) - (0/3) * LOG_2(0/3)$ $= (1) * LOG_2(1) - (0) * LOG_2(0)$ $= 0$	<p>d. Less</p> $Entropy(S)_{Kurang} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (0/1) * LOG_2(0/1) - (1/1) * LOG_2(1/1)$ $= (0) * LOG_2(0) - (1) * LOG_2(1)$ $= 0$
<p>e. Gain</p> $Gain(S, A) = \frac{Entropy(S) - \sum_{V \in Values(A)} \frac{S_i}{S} Entropy(S_v)}{SplitInformation(S, A)}$ $= (9/17 * 0) - (4/17 * 0) - (3/17 * 0) - (1/17 * 0)$ $= (0,3228 - 0)$ $= 0,3228$	

### 3. Social

<p>a. Very Good</p> $Entropy(S)_{AmatBaik} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (7/8) * \text{LOG}_2(7/8) - (1/8) * \text{LOG}_2(1/8)$ $= (0,875) * \text{LOG}_2(0,875) - (0,125) * \text{LOG}_2(0,125)$ $= 0,5436$	<p>b. Good</p> $Entropy(S)_{Baik} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (3/3) * \text{LOG}_2(3/3) - (0/3) * \text{LOG}_2(0/3)$ $= (1) * \text{LOG}_2(1) - (0) * \text{LOG}_2(0)$ $= 0$
<p>c. Enough</p> $Entropy(S)_{Cukup} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (6/6) * \text{LOG}_2(6/6) - (0/6) * \text{LOG}_2(0/6)$ $= (1) * \text{LOG}_2(1) - (0) * \text{LOG}_2(0)$ $= 0$	<p>d. Gain</p> $Gain(S, A) = \frac{Entropy(S) - \sum_{V \in \text{values}(A)} \frac{S_i}{S} Entropy(S_v)}{SplitInformation(S, A)}$ $= (8/17 * 0,5436) - (3/17 * 0) - (6/17 * 0)$ $= (0,3228 - 0,2558117)$ $= 0,066988$

### 4. Professional

<p>a. Very Good</p> $Entropy(S)_{AmatBaik} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (3/3) * \text{LOG}_2(3/3) - (0/3) * \text{LOG}_2(0/3)$ $= (1) * \text{LOG}_2(1) - (0) * \text{LOG}_2(0)$ $= 0$	<p>b. Good</p> $Entropy(S)_{Baik} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (5/5) * \text{LOG}_2(5/5) - (0/5) * \text{LOG}_2(0/5)$ $= (1) * \text{LOG}_2(1) - (0) * \text{LOG}_2(0)$ $= 0$
<p>c. Enough</p> $Entropy(S)_{Cukup} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (8/8) * \text{LOG}_2(8/8) - (0/8) * \text{LOG}_2(0/8)$ $= (1) * \text{LOG}_2(1) - (0) * \text{LOG}_2(0)$ $= 0$	<p>d. Less</p> $Entropy(S)_{Kurang} = \sum_{i=1}^c - P_i \log_2 P_i$ $= (0/1) * \text{LOG}_2(0/1) - (1/1) * \text{LOG}_2(1/1)$ $= (0) * \text{LOG}_2(0) - (1) * \text{LOG}_2(1)$ $= 0$
<p>e. Gain</p> $Gain(S, A) = \frac{Entropy(S) - \sum_{V \in \text{values}(A)} \frac{S_i}{S} Entropy(S_v)}{SplitInformation(S, A)}$ $= (3/17 * 0) - (5/17 * 0) - (8/17 * 0) - (1/17 * 0)$ $= (0,3228 - 0)$ $= 0,3228$	

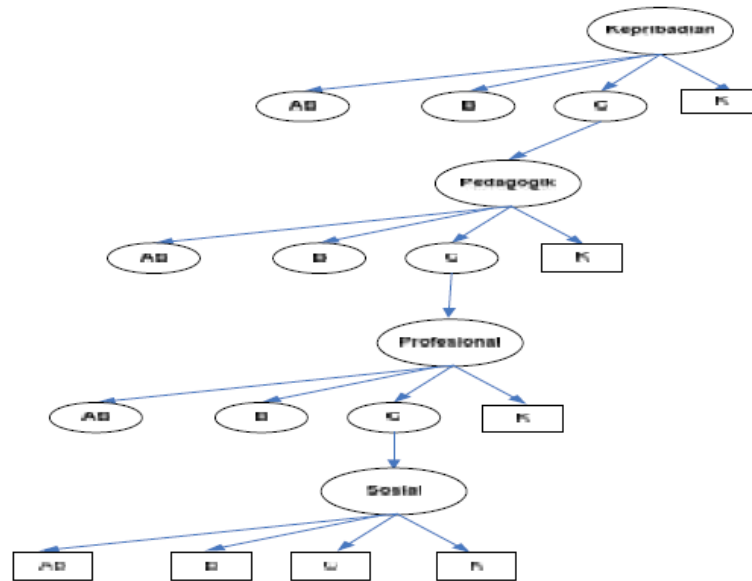
From the results above, it can be seen in table 6 as follows:



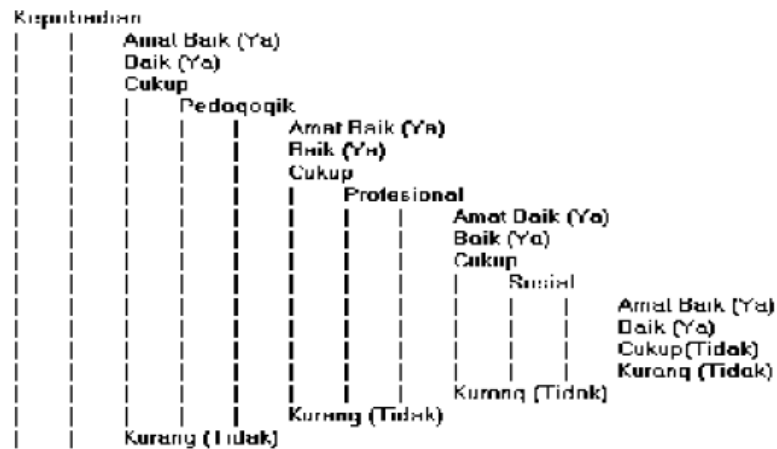
**Table 6.** Appraisal of Attributes

Atribut	Information gain
Pedagogic	0,030706
Personalty	0,3228
Social	0,066988
Profesional	0,3228

From the results above can be described the decision tree image as follows:



**Figure 4.** Manual Decision Tree Display



**Figure 5.** Computerized Decision Tree Display



After obtaining the results of the average decision tree process in table 5 above, the last step is to measure merit pay optimization, namely calculating the amount of merit pay compensation for each teacher according to linguistics and the average decision tree (Z) value obtained, the results can be seen in table 7 as below:

Table 7. Merit Pay Optimization

id	Average	Lingustic	Cost	Merit Pay
835	86.31	Enough	Rp.1.500.000	Rp. 1.294.650
836	72.62	Medium	Rp.1.000.000	Rp. 726.200
837	89.88	Good	Rp.2.000.000	Rp. 1.797.600
838	93.75	Good	Rp.2.000.000	Rp. 1.875.000
839	90.03	Good	Rp.2.000.000	Rp. 1.800.600
840	82.89	Enough	Rp.1.500.000	Rp. 1.243.350
841	81.99	Enough	Rp.1.500.000	Rp. 1.229.850
842	92.41	Good	Rp.2.000.000	Rp. 1.848.200
843	93.75	Good	Rp.2.000.000	Rp. 1.875.000
844	100	Very good	Rp.3.000.000	Rp. 3.000.000
845	75.89	Enough	Rp.1.500.000	Rp. 1.138.350
846	86.76	Enough	Rp.1.500.000	Rp. 1.301.400
847	78.87	Enough	Rp.1.500.000	Rp. 1.183.050
848	88.1	Enough	Rp.1.500.000	Rp. 1.321.500
849	84.08	Enough	Rp.1.500.000	Rp. 1.261.200
850	83.93	Enough	Rp.1.500.000	Rp. 1.258.950
851	76.79	Enough	Rp.1.500.000	Rp. 1.151.850

### Conclusion

Based on the results of testing and discussion, especially the results of merit pay compensation in table 7, it can be seen that the proposed model succeeded in making merit pay compensation more objective according to the performance of each subject teacher. The value of teacher

performance obtained from each teacher will be made a recommendation to the head of department or headmaster for the assessment of one teacher in terms of making a decision in merit pay compensation payments.

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