

## DETERMINATION OF STANDARD TIME IN PACKAGING PROCESSING USING STOPWATCH TIME STUDY TO FIND OUTPUT STANDARD

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**Abstract** Time is one of the factors to assess a worker's performance in utilizing the available resources. Operator in his work requires efficient time to improve work productivity. One of factory in produce a shrimp feed in Surabaya has a large production level. In the production process, the packaging department in this company still uses human resources in their production process and the company define the standard of production without using standard time. This paper investigates the opportunity a logical analysis in determining the standard time in this company. The determination of the standard time in the packaging process requires comprehensive analysis. Objects observed are four operators in the packaging department that carried out the activities of filling bag the shrimp feed with 40 replication for each data. The work measurement was conducted by direct method using Stopwatch Time Study (STS) with snap-back method. The results of this study indicate the standard time value of the four lines packaging is not much different or almost the same. Sequentially the standard time workers line 1 to line 4 is 7.325 seconds, 7.240 seconds, 7.225 seconds, and 7.065 seconds. Allowance used for workers is 8%. However, the existing production rate of company is higher than the production rate of work measurement calculation. This is due to the difference of definition in employee allowance rate and performance rating.

**Keywords:** Output Standard , Productivity, Standard time, Stopwatch time study

### 1. Introduction

Industrial competition make the company will always grow and provide the difference in the form of competitive advantage. To have a competitive advantage the company will seek to optimize their inputs consisting of machinery, labor, energy, capital, information to produce a product. One of the characteristics of a company that has a competitive advantage is a company that is able to respond to customer demand quickly. Timeliness is one factor in generating competitive advantage in addition to unique products, customer value, and financial value[1]. Company must be able to improve production activities in order to supporting the company's efforts in meeting the needs. one way that companies can do to improve productivity is through work measurement [2]. Production is related to time in every company. Company must balanced the processing time in order to ensure the

smoothness of flow processing. Conversely, if the process time is not balanced, then the production process is not optimal and cause the bottle neck problem. Company engaged in the manufacture of shrimp feed is one of the processes still use human in department of packaging. But in the process the company has not set the standard time in accordance with the rules that can later be used in the calculation of standard output. Work measurement will make the job easier due to standard work elements and timings that eliminate waste and inconsistency [3], [4]. In addition, through work measurement can also improve efficiency in the use of equipment that can support efficiency in the man machine interactions [5].

Standard time is calculated using normal time that considering allowance based on worker conditions. Normal time itself is the time required by a qualified operator to complete his work under normal conditions [6]. In performing work measurement an observer should consider the factors that affect the performance of a operator, such as control factor or noise factor [7].

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The determination of this standard time is very important for production especially for production which still uses manual process (human labor) as main factor. Anything that supports the workforce should be considered including performance rating and allowance. Performance rating is an activity used to assess or evaluate the speed of an operator's work [8]. Performance rating is done by comparing the assessment with the ability of existing standards that is the standard of the worker's ability under normal conditions. While allowance is the allocation of time given to the operator for the fatigue, personal needs, and other reasons beyond the control of the operator [6]. By setting the standard time, the company can realize the target.

The purpose of this research is to calculate the standard time on 4 line packaging of shrimp feed product, to determine the allowance that can be given during work, and determine the comparative analysis of output from company with standard output calculation. This research was conducted by observing the 4 operators in each line packaging in process of filling shrimp feeding bag. The data taken in 40 replication consisting of 3 elements of work. The timing of work standard is to use direct measurement which is stopwatch time study with snap back method. Measurement performance rating using Westing House System Rating. Assuming Confidence Level of 95% and Degree of Accuracy of 5%, and normal distribution of data.

## 2. Research Methods

This study was conducted by measuring working time by sequence such as activity time measurement, uniformity test, adequacy test, determination of performance rating, allowance, standard time, and standard output.

- a. Measurement of activity time
- b. This measurement is to identify the average time of shrimp feed filling activity. This time measurement is done by using stopwatch time study with snap back method. The result will be tested for uniformity and adequacy. When not meeting the uniformity and adequacy it will be retrieval data.
- c. Testing Uniformity of data

A set of data we can call uniform when it

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is within the upper control limits and lower control limits. The formula used in the calculation of data uniformity is as follows [6].

$$ULS, LSL = \bar{x} \pm 3\sigma \quad (1)$$

Explanation:

$\bar{x}$  : average of processing time

$\sigma$  : deviation standard of data

- d. Testing adequacy of Data  
Testing adequacy of data is done on result of a set activity time with the aim whether data collection has been sufficiently representative of the population. To perform this test use 5% accuracy and 95% confidence [9].
- e. Determination of performance rating  
The determination of the performance rating is to observe the activities undertaken by the operator based on the Westing House rating system which consists of four elements [6]:  
  - 1) Effort
  - 2) Ability
  - 3) Consistency
  - 4) Condition
- f. Determination of allowance  
The determination of allowance in this study is based on four considerations:  
  - 1) Personal needs of the operator
  - 2) Fatigue
  - 3) Avoidable delay
  - 4) Unavoidable delay
- g. Determination of Standard time  
Standard time is calculate based on the normal time that calculated by performance rating and allowance. This standard time is useful for companies in determining [6]:  
  - 1) Manpower planning
  - 2) Estimated costs for wages of employees
  - 3) Production scheduling and budgeting
  - 4) Planning a bonus reward system and incentives for outstanding employees or workers
  - 5) Identification of output that can be produced by a worker.

The standard time is calculated by equation 2[6].

$$Ws = Wn x \frac{100\%}{100\% - \%Allowance} \quad (2)$$

After obtaining the standard time, we can calculate the standard output (unit) with equation 3 [6].

$$Output\ standard = \frac{1}{ws} \quad (3)$$

### 3. Result and Discussion

In this section, explained about data collection, data processing, and data interpretation. The following is a description of the results and discussion related to the standard time and standard output of shrimp feed companies.

#### 3.1 Data Collection

Prior to data collection, the equipment required for a working measurement activity with stopwatch include:

1. Stopwatch
2. Time study board
3. Time study form

4. Stationery

5. Calculator

Then separate of work into several elements of work. Below is the elements in the packaging process.

**Table 1.** Element of work at Packaging Processing

No	Work Element	Symbol
1	Loading shrimp feed bag into machine	A
2	Fill the bag with shrimp feed untill full	B
3	Set the bag for sewing process	C

Time data (second) taken from packaging departemen we can see at table 2. To analyze the conformity of time given to the target set by the company that we can see at table 3, we need amount of data and hours of employee out source as a comparative calculation.

**Tabel 2** Data of Packaging Process at Line 1-4

No.	Elemen Kerja Line 1			Elemen Kerja Line 2			Elemen Kerja Line 3			Elemen Kerja Line 4		
	A	B	C	A	B	C	A	B	C	A	B	C
1	1,8	4,1	0,9	1,9	3,2	1,4	1,9	3,5	1,5	1,7	3,7	0,9
2	1,2	3,7	1,0	1,8	3,5	1,5	1,4	3,4	1,9	1,4	3,6	1,2
3	1,1	4,4	0,9	2,2	3,4	0,8	1,2	3,1	1,9	1,5	3,4	1,4
4	1,9	3,5	0,6	1,5	3,2	1,1	2,0	3,5	1,7	1,9	3,2	0,9
5	1,3	5,1	1,0	1,4	4,3	1,1	1,9	3,9	1,5	1,8	3,1	1,1
6	1,5	3,4	1,0	2,1	3,6	1,3	1,5	3,1	0,9	1,9	3,5	1,0
7	1,4	4,4	1,2	1,0	4,3	1,5	1,9	3,5	1,2	1,9	3,9	1,0
8	1,5	3,8	1,0	1,2	3,2	1,7	1,8	3,5	1,0	1,7	3,3	1,3
9	1,5	4,6	1,0	1,8	3,0	0,9	1,7	3,9	1,2	1,6	3,8	1,3
10	1,0	4,1	0,8	1,9	4,4	1,6	1,7	3,0	1,0	1,2	4,0	1,0
11	1,9	5,0	1,1	1,5	4,5	1,4	1,5	3,5	1,3	1,8	3,2	1,4
12	1,6	3,8	1,2	1,4	3,5	1,6	1,8	3,9	1,7	1,9	4,0	1,5
13	1,8	4,2	0,9	1,2	4,5	1,4	1,7	3,9	1,7	1,5	3,5	0,9
14	1,9	5,1	1,4	1,5	3,2	1,5	1,9	3,8	0,9	1,2	3,3	1,3
15	1,9	4,9	0,9	1,9	3,5	1,6	1,4	4,0	1,2	1,1	3,6	1,0
16	1,9	4,3	0,8	1,8	3,3	1,5	1,2	3,0	1,4	1,5	3,9	1,3
17	1,5	3,4	1,0	1,9	3,8	1,7	1,4	3,6	1,5	1,3	3,3	0,9
18	1,0	4,8	0,8	1,8	3,6	1,4	1,3	3,5	1,5	1,5	3,2	1,5
19	1,7	4,1	1,0	1,8	3,8	1,3	1,2	3,3	1,0	1,5	3,2	1,5
20	1,6	4,2	0,9	1,7	4,3	1,4	1,3	3,6	1,7	1,3	3,6	1,1
21	1,5	3,9	0,8	1,9	4,3	1,6	1,9	3,2	1,7	1,4	3,0	1,5
22	1,9	3,6	1,1	1,5	3,3	1,7	1,9	3,7	1,5	1,9	3,1	1,6
23	1,7	3,9	0,9	1,7	3,6	1,1	1,7	3,3	1,9	1,7	3,9	1,7
24	1,9	3,5	1,3	1,6	3,1	1,0	1,3	3,5	1,2	1,6	3,4	1,1
25	1,5	3,1	1,2	1,6	3,8	1,7	1,9	3,0	1,6	1,1	4,0	1,7
26	1,5	3,6	1,3	1,9	3,5	1,8	1,7	3,5	0,9	1,4	3,7	1,1
27	1,2	3,7	1,3	1,7	4,7	0,9	1,6	4,1	1,5	1,1	3,5	1,1
28	1,3	3,3	0,8	1,5	4,7	0,8	1,3	3,1	0,9	1,6	3,3	0,9
29	1,4	3,8	1,0	1,9	3,9	0,8	1,4	3,3	1,7	1,6	3,0	1,8
30	1,3	3,1	1,3	1,2	4,4	1,0	1,8	3,6	1,7	1,3	3,1	0,9
31	1,4	4,2	0,5	1,2	3,4	1,1	1,2	3,3	1,5	1,4	3,6	1,6
32	1,5	3,0	0,6	2,1	4,2	1,2	2,1	3,9	1,4	1,4	3,6	1,1
33	1,4	3,5	1,0	1,3	3,9	0,8	2,0	3,4	1,6	1,4	3,2	1,7
34	1,0	5,0	0,9	2,1	3,1	1,0	1,6	3,6	1,1	1,7	3,1	1,0
35	1,5	3,7	1,3	1,5	3,8	1,2	1,7	3,6	1,3	1,6	3,1	1,5
36	1,8	3,9	1,0	1,4	3,5	1,0	1,9	3,5	1,7	1,6	3,7	1,4
37	1,9	4,6	1,3	1,8	3,2	1,2	1,2	3,1	1,2	1,4	3,8	1,0
38	1,4	4,9	1,4	1,5	3,1	0,9	1,5	3,9	1,1	1,4	3,0	1,2
39	1,5	3,0	1,4	1,9	3	1,2	1,6	3,1	0,9	1,6	3,5	1,4
40	1,6	4,4	1,2	1,5	3,9	1,5	1,7	3,8	1,9	1,2	4,0	1,7
<b>Jumlah</b>	<b>61,2</b>	<b>160,6</b>	<b>41</b>	<b>66,1</b>	<b>148,5</b>	<b>51,2</b>	<b>64,7</b>	<b>140</b>	<b>56</b>	<b>60,6</b>	<b>138,9</b>	<b>80,5</b>
<b>Rata-Rata</b>	<b>1,53</b>	<b>4,015</b>	<b>1,03</b>	<b>1,653</b>	<b>3,713</b>	<b>1,28</b>	<b>1,617</b>	<b>3,5</b>	<b>1,4</b>	<b>1,515</b>	<b>3,473</b>	<b>1,263</b>

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**Table 3.** The Amount of Data dan Feed Processing Time

Line	Amount of Pallet	Amount of Unit	Work hour
1	8	560 unit	07.00-08.00 09.00-10.00
2	8	560 unit	13.00-14.00
3	7	490 unit	07.00-08.00 09.00-10.00
4	8	560 unit	07.00-08.00 09.00-10.00

**Table 4.** The Amount of Data and Total Production Time

Line	Total Pallet	Amount of Unit	Work Hour
1	24	1680 Unit	180 Minutes
2	24	1680 Unit	180 Minutes
3	14	980 Unit	120 Minutes
4	16	1120 Unit	120 Minutes

### 3.2 Data Processing

In data processing we test data in uniformity and adequacy.

#### 3.2.1 Uniformity Test at Packaging

The following is a uniformity test of data for each work element's data:

For example the uniformity of data from line 1.

Average processing time at work element A with interval confidence 95%,  $k = 2$

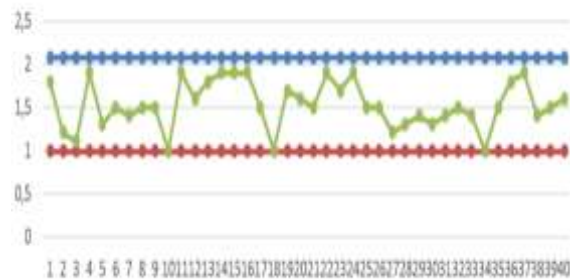
$$\bar{X} = \frac{\sum X_i}{n} = \frac{1,8+1,2+1,1+1,9+1,3+\dots+1,6}{40} = 1,53 \text{ second}$$

$$\sigma = \sqrt{\frac{\sum(X_i - \bar{X})^2}{n-1}} = 0,272$$

$$UCL = \bar{X} + k\sigma = 1,53 + 2(0,272) = 2,074$$

$$LCL = \bar{X} - k\sigma = 1,53 - 2(0,272) = 0,986$$

From the graph at figure 1 explains that the data value of each element A lies between the upper limit data control value and the lower control limit. So the data value is not the outlier (in control). With the same calculation obtained the following results at table 5 until table 8.



**Figure 1.** Graph Test Uniformity Test Elements A Line 1

**Table 5.** Homogeneity Test of Packaging Line 1

Work Element	SD	USL	LSL	Information
A	1,272	2,074	0,98	Uniform
B	1,608	5,232	2,9798	Uniform
C	0,192	1,446	0,678	Uniform

**Table 6.** Homogeneity Test of Packaging Line 2

Work Element	SD	USL	LSL	Information
A	0,273	2,216	1,122	Uniform
B	0,51	4,732	2,693	Uniform
C	0,301	1,881	0,679	Uniform

**Table 7.** Homogeneity Test of Packaging Line 3

Work Element	SD	USL	LSL	Information
A	0,268	2,115	1,079	Uniform
B	0,306	4,113	2,887	Uniform
C	0,320	2,041	0,759	Uniform

**Table 8.** Homogeneity Test of Packaging Line 4

Work Element	SD	USL	LSL	Information
A	0,234	1,984	1,045	Uniform
B	0,319	4,111	2,833	Uniform
C	0,278	1,818	0,707	Uniform

#### 3.2.2 Adequate Test Packaging Data

From the test, indicates that the data is sufficient with indication the number of samples ( $N$ ) = 40 is greater than the number of samples that should be taken ( $N'$ ) = 13. With same calculation Table 9 show us about the result of adequate test for other line.

#### 3.2.3 Allowance Values for Packaging Operator

Measurement allowance of this case study involves time chatting with a coworker and cleaning the hands of feed dust, as well as the effect of waiting time for forklift arrival

from operator moving pallet to storage.

**Table 9.** Result of Adequate Test for Line 1, 2, 3, 4

Line	Element	N	N'	Information
1	A	40	13	Enough
	B	40	9	Enough
	C	37	13	Enough
2	A	39	11	Enough
	B	40	8	Enough
	C	40	22	Enough
3	A	40	11	Enough
	B	40	3	Enough
	C	40	21	Enough
4	A	40	10	Enough
	B	40	4	Enough
	C	40	19	Enough

**Table 10.** Allowance Time of Worker

operator	Time (second)	Total
Line 1	54+117	231
Line 2	47+216	263
Line 3	41+131	172
Line 4	24+173	197

**Table 11.** Allowance Percentage of Worker

Operator	Work Hour	Allowance time	Percentage Allowance
Line 1	3600	231	6,42%
Line 2	3600	263	7,31%
Line 3	3600	172	4,78%
Line 4	3600	197	5,47%
Adjustment Allowance		Allowance	
Line 1		8%	
Line 2		8%	
Line 3		8%	
Line 4		8%	

From the table 10 and 11 shows the allowance on each worker by rounding up. The result of allowance is used in the next calculation.

### 3.2.4 Calculation of Cycle Time, Normal Time, Standard Time, Standard Output at Packaging Process

Calculating of cycle time, normal time, and standard time we considering the value of the predetermined performance rating and allowance. Below is the example. line 1:

Element 1:

a. Cycle time

$$WCycle = \frac{\sum Xi}{N} = \frac{1,8+1,2+1,1+1,9+1,3+\dots+1,6}{40} = 1,53 \text{ second}$$

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b. Normal Time

$$Wnormal = Wsiklus \times P = 1,53 \times 1,02 = 1,561 \text{ second}$$

c. Standard Time

$$Wstandard = Wn \times \frac{100\%}{100\% - \%Allowance} = 1,561 \times \frac{100\%}{100\% - 8\%} = 1,696 \text{ second}$$

With the same calculation obtained results for cycle time, normal time, and standart time at Table 12 until 15.

**Table 12** Cycle Time, Normal Time, and Standard Time at Line 1

Work Element	Cycle Time	Normal Time	Standard Time
A	1,530	1,561	1,696
B	4,015	4,095	4,451
C	1,062	1,083	1,177
Total	6,607	6,739	7,325

**Table 13** Cycle Time, Normal Time, and Standard Time at Line 2

Work Element	Cycle Time	Normal Time	Standard Time
A	1,669	1,669	1,814
B	3,713	3,713	4,035
C	1,280	1,280	1,391
Total	6,662	6,662	7,240

**Table 14** Cycle Time, Normal Time, and Standard Time at Line 3

Work Element	Cycle Time	Normal Time	Standard Time
A	1,617	1,649	1,793
B	3,5	3,570	3,880
C	1,400	1,428	1,552
Total	6,517	6,647	7,225

**Table 15** Cycle Time, Normal Time, and Standard Time at Line 4

Work Element	Cycle Time	Normal Time	Standard Time
A	1,515	1,575	1,713
B	3,473	3,611	3,925
C	1,263	1,313	1,427
Total	6,250	6,500	7,065

Result of standard time in at line 1-4 use to calculate output standard using equation 3.

1. Output standard for line 1

$$Output\ standard = \frac{1}{Standard\ Time} = \frac{1}{7,325} \text{ unit/second} = 0,137 \text{ unit/second} = 8,191 \text{ unit/minutes} \approx 9 \text{ unit/minutes}$$



2. Output standard for line 2

$$\begin{aligned} \text{Output standard} &= \frac{1}{\text{Standard Time}} \\ &= \frac{1}{7,240} \text{ unit/second} = 0,138 \text{ unit/second} \\ &= 8,287 \text{ unit/minutes} \approx 9 \text{ unit/minutes} \end{aligned}$$

3. Output standard for line 3

$$\begin{aligned} \text{Output standard} &= \frac{1}{\text{Standard Time}} \\ &= \frac{1}{7,225} \text{ unit/second} = 0,138 \text{ unit/second} \\ &= 8,303 \text{ unit/minutes} \approx 9 \text{ unit/minutes} \end{aligned}$$

4. Output standard for line 3

$$\begin{aligned} \text{Output standard} &= \frac{1}{\text{Standard Time}} \\ &= \frac{1}{7,065} \text{ unit/second} = 0,142 \text{ unit/second} \\ &= 8,492 \text{ unit/minutes} \approx 9 \text{ unit/minutes} \end{aligned}$$

### 3.3 Data Interpretation

The company in calculating the productivity of workers in the packaging only by dividing the number of production units with total working hours.

$$\text{Productivity} = \frac{\text{Output packaging (unit Input)}}{\text{work hours(Output)}} \quad (4)$$

Based on the company's production data can be calculated as follows:

Line 1 :

$$\begin{aligned} \text{Final Output} &= 560 \text{ unit} : 60 \text{ minutes} \\ &= 9,333 \text{ unit/minutes} \\ &\approx 10 \text{ unit/minutes} \end{aligned}$$

Line 2 :

$$\begin{aligned} \text{Final Output akhir} &= 560 \text{ unit} : 60 \text{ menit} \\ &= 9,333 \text{ unit/menit} \\ &\approx 10 \text{ unit/minutes} \end{aligned}$$

Line 3 :

$$\begin{aligned} \text{Final Output} &= 490 \text{ unit} : 60 \text{ minutes} \\ &= 8,167 \text{ unit/minutes} \\ &\approx 9 \text{ unit/minutes} \end{aligned}$$

Line 4 :

$$\begin{aligned} \text{Final Output} &= 560 \text{ unit} : 60 \text{ menit} \\ &= 9,333 \text{ unit/menit} \\ &\approx 10 \text{ unit/menit} \end{aligned}$$

Based on Table 16. Shows the results of calculation of productivity of the company is greater than the results of the calculation of the

work measurement. This is because the company does not take into account the allowance and performance rating for workers.

**Table 16.** Comparison Between Output Target with Output Standard for Work Measurement

Line	Output Standard form Company	Output Standard From Work Measurement Calculation
1	10	9
2	10	9
3	9	9
4	10	9

Allowance given to workers is different, because every worker has different needs. However, in order to keep balance between workers, 8 percent allowance can be used for all workers in every working hours. Calculations by the authors can be used as a reference or standard of the productivity of each worker. Thus, workers are expected to increase productivity over time to be able to exceed output targets. In addition, from the company at least also helps increase the productivity of these workers, for example help improve the layout of facilities for storage. So with the arrangement of the location of a good warehouse to worker in finding the place needed in storage.

### 4. Conclusions

Based on data analysis shows that the value of availability rate is 88.82%, performance rate 93.70%, and quality rate 98.20%; then the OEE values obtained 81.73%. The dominant factor of losses is high downtime due to mechanical motor breakdown that is 24% or 1160 minutes, and duration of setup time is 19.4% or 935 minutes.

Types of activities that are at the root of the problem include: no lubrication periodically, delaying clean up the dirt on the machine, heating furnace is too long at the time of machine setup, material storage (animal compost) and fuel (coal) in the open space. The solutions offered to PT.SBK as a step to increase machine performance improvements are by: revise the machine maintenance schedule to be more frequently, improving more practical hygiene procedures and adding aids, making a special storage place closed for

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materials and fuel, as well as conducting training to employees at all levels.

#### 4. Conclusion

From result of observation of work measurement by using stopwatch method of Time Study at 4 line packaging can be concluded as follows: Standard time is a reasonable time required by a normal worker to complete his work done in the best working system of the day. From the calculation results obtained standard time required in completing the target company of 4 line packaging is not much different / almost the same. Sequentially the standard time workers line 1 to line 4 is 7.325 seconds, 7.240 seconds, 7.225 seconds, and 7.065 seconds. Thus, have a level of ability or productivity that is not much different. Allowance is special times needed for personal needs, rest breaks, and other reasons out of control. The sharing of this case study allowance is to chat with co-workers, clean hands of feed dust, and influence the waiting time for forklifts from carriers that move pallets to storage. Determination of allowance can be adjusted for each worker needs and according to the calculation of data obtained there are some allowance that is 6.42%, 7.31%, 4.78%, and 5.47% for each line. Thus, the allowance that can be used is 8% taken from the largest allowance rounding result because it has been in accordance with the consideration of time and output target. In addition, with the use of the largest allowance has been able to represent a small allowance. Comparison of company output with standard timing output on 4 line packaging, ie the output produced by the company is higher than the calculation output. Ouput company with calculation output there is difference difference, sequentially from line 1 to line 4 workers that is 1 unit / minute, 1 unit / minute, 0 unit / minute, and 1 unit / minute in reaching production target. This is due to the influence of employee allowance and performance rating.

Suggestions that can be given are: The addition of a forklift to reduce the waiting time on moving the pallet to the warehouse or by changing the warehouse layout to facilitate the searching or placement of the finished feed. Companies may use standard time to make judgments in determining hours of work or

incentives for workers.

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