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Establishment of Standard Time on Inspection Process: A Process Innovation Opportunity

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ABSTRACT

Time study is one of the methods that can be utilized in identifying the labour standards. The execution of time study may help in establishing the standard time that valuable to the organization in setting up the guidelines for their employees in order to efficiently completing the job and measuring the workers' performance. Honing is one of inspection activities that need to be completed in producing advanced ceramic product. In practice there is no standard time developed for this process until now. There are four elements in the honing process which are; collecting and rubbing; visualizing; checking the four sides of the product; and taping. Since it is labour intensive process performed manually, it is crucial to identify the most efficient time in completing the task. The primary data was rigorously gathered by using observation procedure. Thirty initial observations were conducted in order to identify the standard deviations before deciding the exact number of observation which was 66 observations. Calculating the normal time took precedence over the standard time. The total normal time for honing process was 0.17 minute. By considering the 21.5% of allowance factor, it was found that the standard time for honing process was 0.2166 minute (13 seconds). Ultimately, it is expected that the company can benefited in capitalizing the calculated standard time as their benchmark in setting up the duration for honing process. It is because workers and time are inputs that tie productivity which inevitable to compromise.

KEYWORDS: Honing Process, Time Study, Performance Rating, Normal Time, Allowance Factor.

INTRODUCTION

Process innovations are innovations in the way an organization conducts its business, such as in the techniques of producing or marketing goods and services. Process innovation would give a big impact to the production flow of a particular operation whether it is goods or service oriented process. The purpose of process innovation is to increase the efficiencies or the effectiveness of production or an organization [1, 2]. Standard time can be treated as a benchmark time for the workers in completing their task. In addition, the manager can forecast the output of the production by referring to the standard time. Thus, process innovations help to improve the output-to-input ratio of the firm.

Time study is the most widely used techniques in work measurement and also known as classical stopwatch because it used stopwatch to record the time. Over the years, time and motion studies had been done in many industries. Both are to ascertain how long it takes to do a given job and to improve it through setting production goals and reducing unnecessary steps in a process [3].

According to the supervisor at honing section, as to the date there is no standard time established for the process. Therefore, establishing standard time for this section would become a significant contribution to the company. A standard time could be utilized as a mechanism towards lean production where saving seconds may boosts productivity.

Objectives

- To determine number of observations needed for the study
- To determine the average observe time for each element
- To determine the total normal time for the honing process
- To determine the standard time for the honing process

Scope and Limitation of Study

The study was conducted at a company that produces advanced ceramic product focusing on honing section. Honing is selected because it is a labour intensive process after completing the first four automated processes. To

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execute the time study, the speed rating was used in determining the performance rating. Allowances used in this study are personal allowance, basic fatigue allowance, variable fatigue allowance and unavoidable delays allowance.

The Honing Process

Basically, honing is an inspection task. Since powder is used in order to make sure the surfaces of the semi-finished products smoother, rubbing, visualizing, checking, and taping activities are performed in detecting any defect on the products' surfaces.

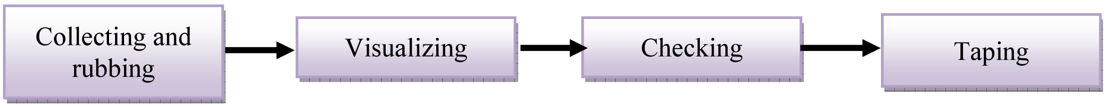

Figure 1: The honing process

Figure 1 shows that there are four elements in honing process which are collecting and rubbing, visualizing, checking, and taping. The purpose of rubbing is to detect and remove any zara on the products' surfaces. Visualizing is conducted in order to detect is there any crack on the products. During checking the four sides of the product is checked. The last element is taping the product by using loytape. The purpose of taping is to ensure that the products are fit.

LITERATURE REVIEW

Work Measurement Studies

Work measurement study is a general term used to describe the systematic application of industrial engineering techniques to establish the work content and time it should take to complete a task. It refer to the estimation of standard time, that is the time allowed for completing one piece of job using the given method. This is the time taken by an average experienced worker or competent worker for the job with provisions for delays beyond the workers control. It has been a traditional management tool in manufacturing organizations. This work measurement is still commonly practiced and seems to be more popular across the rest of European that it does in the United Kingdom [4]. Contemporary, work measurement was founded at the turn of the century by Frederick Taylor. He created a technique for standardizing performance times of repetitive operations by specifying the method of operation and by timing the component tasks with a stopwatch.

Work measurement is concerned with investigating, reducing and eliminating ineffective time, that is time during which no effective work is being performed, whatever the cause [5]. Through this work measurement, any ineffective time can be detected in order to help the organization increase their productivity. The total time to manufacture the products had increased when there has an add-in undesirable feature to product, bad operations and ineffective time added because of worker and management. All of these can lead to decrease the productivity. The purpose of measurement programme is to achieve a full coverage of the work to be measured, at a level of detail commensurate with the aims of the measurement programme and to achieve it cost-effectively [4].

Time Study

Time study is the most widely used work measurement technique that employs a decimal minute stopwatch to record and determine the time required by a qualified and well-trained person working at a normal pace to do a specific task under specified conditions. Time study defines as "timing a sample of a worker's performance and using it as a basis for setting a standard time" [6]. The result of the time study is the time that a person suited to the job and fully trained in the specified method will need to perform the job if they work at abnormal or standard pace [7]. In conducting the time study the average observed time must be computed. Then, the average observed time must be adjusted for pace which lead to normal time. Finally, the total normal time must be adjusted to the allowance factor in computing the standard time.

Performance Rating

Performance rating is the pace of the worker in performing their work. It is crucial to identify the performance rating because different worker works at different level of performance based upon their categories of workers, work background, level of education and experience, and diverse attitude and skills level. Workers that focus and hardworking is more efficient as compared to attitudinal problems. The fast and speedy working performance would have 100% performance rating; moderate or not too fast neither too slow worker. It can be considered as an average worker would have 100% performance rating; slow, unsure of work steps, or having difficulty in task would scored less than 100% of performance rating [8].

Allowance Factor

Agreeing with the fact, no worker works all the time during the working day lead to the reasons of allocating the allowance factor. Classes of interruption can be in terms of personal interruption such as trips to restroom and drinking fountain; second is fatigue; and the third is unavoidable delays such as tool breakage, supervisor interruptions, slight tool trouble, and material variation [9].

RESEARCH METHOD

A basic research was conducted in exploring the time study theory at honing section by executing an observation as a mode of data collection method. During the observation, the stop watch was used in measuring the time taken for each activity.

Time Study Procedure

There are six steps to be followed in conducting the time study [6].

Step 1-Execute the initial observations

For this study, 30 initial observations were conducted as time studies often involve only small samples (n < 30) [9].

Step 2-Calculate the standard deviation

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{\sum (\text{each sample observation} - \bar{x})^2}{n-1}} \tag{1}$$

Step 3-Identify the number of full observation.

$$n = \left[\frac{z.s}{h\bar{x}}\right]^2 \tag{2}$$

Step 4-Calculate the Average Observe Time (AOT)

$$\text{Average observed time} = \frac{\text{(Sum of times recorded to perform each element)}}{\text{Number of each observation}} \tag{3}$$

Step 5-Calculate the Normal Time (NT)

$$\text{Normal Time} = \text{(Average Observed Time) x (Performance Rating Factor)} \tag{4}$$

Step 6-Calculate the Standard Time (ST)

$$\text{Standard Time} = \frac{\text{Normal Time}}{1 - \text{Allowance Factor}} \tag{5}$$

Margin of Error and Performance Rating

In calculating the sample size, the 95% confidence level with 1.96 of z-value and 14% of error (h) was used [10]. Some companies used a speed rating technique normalized to 60% standard, which based on the standard hour approach that is producing 60 min of work every hour [9]. Based on honing's supervisor, the operators can work at a speed of 90/60 or 150% which is 50% above normal. It means that the operators can do one and a half jobs in every work hour.

Allowance factor

Allowance for rest or recovery is add to the basic time because when an operator carrying any work it can induces fatigue when they work non-stop without any break [4]. This study identified the allowances in adjusting the total normal time [9]:

- Personal allowance = 5%
- Basic fatigue allowance = 4%
- Standing allowance = 2%
- Unavoidable delay = 0.75% x 14 machines = 10.5%

For unavoidable delay, 0.75% was taken from the Clean Machine Allowance Chart that represent for shut machine down for cleaning [9]. Therefore, total allowance factor was 21.5%.

ANALYSIS AND DISCUSSION OF RESULTS

Initial Observation

In calculating the sample size, the 95% confidence level with 1.96 of z-value and 14% of error (h) were used [10].

Standard Deviations and Required Sample Size

In Table 1, 2, 3 and 4 show the observed time for initial observation. Thirty observations were conducted for each element. There was no outlier identified from such observations. The purpose of this initial observation was to identify the standard deviation for each element before using it in calculating the required sample size for the exact observation.

Table 1: Standard deviation for element 1

No. of observations	Element 1 (x_i) Collect and Rub the products (min)	$\bar{x}$ (min)	$(x_i - \bar{x})$ (min)	$(x_i - \bar{x})^2$ (min)
1	0.05	0.04	0.01	0.0001
2	0.04	0.04	0.00	0.0000
3	0.05	0.04	0.01	0.0001
4	0.06	0.04	0.02	0.0004
5	0.04	0.04	0.00	0.0000
6	0.04	0.04	0.00	0.0000
7	0.04	0.04	0.00	0.0000
8	0.04	0.04	0.00	0.0000
9	0.05	0.04	0.01	0.0001
10	0.04	0.04	0.00	0.0000
11	0.04	0.04	0.00	0.0000
12	0.05	0.04	0.01	0.0001
13	0.03	0.04	-0.01	0.0001
14	0.04	0.04	0.00	0.0000
15	0.03	0.04	-0.01	0.0001
16	0.03	0.04	-0.01	0.0001
17	0.04	0.04	0.00	0.0000
18	0.04	0.04	0.00	0.0000
19	0.06	0.04	0.02	0.0004
20	0.06	0.04	0.02	0.0004
21	0.03	0.04	-0.01	0.0001
22	0.05	0.04	0.01	0.0001
23	0.05	0.04	0.01	0.0001
24	0.05	0.04	0.01	0.0001
25	0.04	0.04	0.00	0.0000
26	0.04	0.04	0.00	0.0000
27	0.03	0.04	-0.01	0.0001
28	0.03	0.04	-0.01	0.0001
29	0.04	0.04	0.00	0.0000
30	0.04	0.04	0.00	0.0000
Σ	1.27			0.0025

$$s = \sqrt{\frac{0.0025}{29}}$$
$$= 0.009\,\text{min}$$

$$n = \left(\frac{1.96 \times 0.009}{0.14 \times 0.04}\right)^2$$
$$= \left(\frac{0.01764}{0.0056}\right)^2$$
$$= 9.923$$
$$\approx 10\text{ cycles are needed}$$

Table 2: Standard deviation for element 2

No. of observations	Element 2 (x_i) Visualize the products (min)	$\bar{x}$ (min)	$(x_i - \bar{x})$ (min)	$(x_i - \bar{x})^2$ (min)
1	0.04	0.05	-0.01	0.0002
2	0.03	0.05	-0.02	0.0004
3	0.06	0.05	0.01	0.0001
4	0.07	0.05	0.02	0.0004
5	0.08	0.05	0.03	0.0009
6	0.08	0.05	0.03	0.0009
7	0.10	0.05	0.05	0.0025

8	0.05	0.05	0.00	0.0000
9	0.04	0.05	-0.01	0.0001
10	0.03	0.05	-0.02	0.0004
11	0.04	0.05	-0.01	0.0001
12	0.04	0.05	-0.01	0.0001
13	0.04	0.05	-0.01	0.0001
14	0.06	0.05	0.01	0.0001
15	0.13	0.05	0.08	0.0064
16	0.06	0.05	0.01	0.0001
17	0.12	0.05	0.07	0.0049
18	0.02	0.05	-0.03	0.0009
19	0.02	0.05	-0.03	0.0009
20	0.04	0.05	-0.01	0.0001
21	0.02	0.05	-0.03	0.0009
22	0.03	0.05	-0.02	0.0004
23	0.04	0.05	-0.01	0.0001
24	0.03	0.05	-0.02	0.0004
25	0.06	0.05	0.01	0.0001
26	0.10	0.05	0.05	0.0025
27	0.04	0.05	-0.01	0.0001
28	0.03	0.05	-0.02	0.0004
29	0.05	0.05	0.00	0.0000
30	0.03	0.05	-0.02	0.0004
Σ	1.58			0.0249

$$s = \sqrt{\frac{0.0249}{29}}$$
$$= 0.029\,\text{min}$$

$$n = \left(\frac{1.96 \times 0.029}{0.14 \times 0.05}\right)^2$$
$$= \left(\frac{0.05684}{0.007}\right)^2$$
$$= 65.93$$
$$\approx 66 \text{ cycles are needed}$$

Table 3: Standard deviation for element 3

No. of observations	Element 3 (x_i) Check all the four side products (min)	$\bar{x}$ (min)	$(x_i - \bar{x})$ (min)	$(x_i - \bar{x})^2$ (min)
1	0.04	0.02	0.02	0.0003
2	0.03	0.02	0.01	0.0001
3	0.03	0.02	0.01	0.0001
4	0.03	0.02	0.01	0.0001
5	0.02	0.02	0.00	0.0000
6	0.02	0.02	0.00	0.0000
7	0.02	0.02	0.00	0.0000
8	0.02	0.02	0.00	0.0000
9	0.03	0.02	0.01	0.0001
10	0.01	0.02	-0.01	0.0001
11	0.02	0.02	0.00	0.0000
12	0.02	0.02	0.00	0.0000
13	0.03	0.02	0.01	0.0001
14	0.02	0.02	0.00	0.0000
15	0.02	0.02	0.00	0.0000
16	0.02	0.02	0.00	0.0000
17	0.04	0.02	0.02	0.0004
18	0.03	0.02	0.01	0.0001
19	0.02	0.02	0.00	0.0000
20	0.03	0.02	0.01	0.0001
21	0.02	0.02	0.00	0.0000
22	0.03	0.02	0.01	0.0001
23	0.02	0.02	0.00	0.0000
24	0.02	0.02	0.00	0.0000
25	0.02	0.02	0.00	0.0000

26	0.01	0.02	-0.01	0.0001
27	0.02	0.02	0.00	0.0000
28	0.03	0.02	0.01	0.0001
29	0.02	0.02	0.00	0.0000
30	0.02	0.02	0.00	0.0000
Σ	0.71			0.0018

$$s = \sqrt{\frac{0.0018}{29}}$$
$$= 0.008\,\text{min}$$

$$n = \left(\frac{1.96 \times 0.008}{0.14 \times 0.02}\right)^2$$
$$= \left(\frac{0.01568}{0.0028}\right)^2$$
$$= 31.36$$
$$\approx 32 \text{ cycles are needed}$$

Table 4: Standard deviation for element 4

No. of observations	Element 4 (x_i) Taping the products (min)	$\bar{x}$ (min)	$(x_i - \bar{x})$ (min)	$(x_i - \bar{x})^2$ (min)
1	0.04	0.03	0.01	0.0001
2	0.02	0.03	-0.01	0.0001
3	0.02	0.03	-0.01	0.0001
4	0.02	0.03	-0.01	0.0001
5	0.03	0.03	0.00	0.0000
6	0.03	0.03	0.00	0.0000
7	0.03	0.03	0.00	0.0000
8	0.03	0.03	0.00	0.0000
9	0.05	0.03	0.02	0.0004
10	0.04	0.03	0.01	0.0001
11	0.04	0.03	0.01	0.0001
12	0.02	0.03	-0.01	0.0001
13	0.02	0.03	-0.01	0.0001
14	0.02	0.03	-0.01	0.0001
15	0.04	0.03	0.01	0.0001
16	0.03	0.03	0.00	0.0000
17	0.08	0.03	0.05	0.0025
18	0.04	0.03	0.01	0.0001
19	0.04	0.03	0.01	0.0001
20	0.04	0.03	0.01	0.0001
21	0.03	0.03	0.00	0.0000
22	0.04	0.03	0.01	0.0001
23	0.02	0.03	-0.01	0.0001
24	0.03	0.03	0.00	0.0000
25	0.03	0.03	0.00	0.0000
26	0.02	0.03	-0.01	0.0001
27	0.03	0.03	0.00	0.0000
28	0.03	0.03	0.00	0.0000
29	0.03	0.03	0.00	0.0000
30	0.02	0.03	-0.01	0.0001
Σ	0.96			0.0046

$$s = \sqrt{\frac{0.0046}{29}}$$
$$= 0.013\,\text{min}$$

$$n = \left(\frac{1.96 \times 0.013}{0.14 \times 0.03}\right)^2$$
$$= \left(\frac{0.02548}{0.0042}\right)^2$$
$$= 36.8$$
$$\approx 37 \text{ cycles are needed}$$

Table 5: Summary of standard deviation and sample size

Elements	Standard Deviation	Sample
Collect and rub the products	0.009 min	9.923 cycles ~ 10 cycles
Visualize the product	0.029 min	65.93 cycles ~ 66 cycles
Check the four side of the products	0.008 min	31.36 cycles ~ 32 cycles
Taping the products	0.013 min	36.8 cycles ~ 37 cycles

Table 5 summarizes the calculated standard deviations and sample size for each element. After identifying the sample size or number of cycles for each element, it shows that the highest calculated sample needed was 66. Therefore, 36 additional observations were carried out in getting the 66 number of observations.

Standard Time

Table 6: Working of standard time

No. of observations	Element 1 (x_i)	Element 2 (x_i)	Element 3 (x_i)	Element 4 (x_i)
	Collect and Rub the products (min)	**Visualize the products (min)**	**Check all the four side products (min)**	**Taping the products (min)**
1	0.03	0.04	0.02	0.04
2	0.03	0.03	0.02	0.03
3	0.03	0.03	0.03	0.03
4	0.04	0.05	0.02	0.04
5	0.03	0.05	0.02	0.03
6	0.03	0.04	0.02	0.03
7	0.03	0.05	0.03	0.03
8	0.02	0.02	0.03	0.04
9	0.03	0.03	0.02	0.03
10	0.02	0.05	0.01	0.03
11	0.04	0.04	0.04	0.03
12	1.0*	0.05	0.03	0.03
13	0.03	0.04	0.02	0.03
14	0.03	0.05	0.02	0.03
15	0.04	0.06	0.03	0.04
16	0.03	0.03	0.02	0.03
17	0.04	0.04	0.03	0.03
18	0.03	0.04	0.02	0.03
19	0.04	0.04	0.02	0.03
20	0.05	0.03	0.03	0.03
21	0.03	0.03	0.02	0.03
22	0.03	0.03	0.02	0.03
23	0.04	0.04	0.02	0.03
24	0.04	0.05	0.02	0.03
25	0.05	0.03	0.03	0.03
26	0.03	0.03	0.03	0.03
27	0.03	0.03	0.01	0.04
28	0.04	0.04	0.02	0.04
29	0.04	0.05	0.02	0.03
30	0.03	0.06	0.02	0.03
31	0.05	0.05	0.02	0.02
32	0.04	0.04	0.02	0.02
33	0.03	0.04	0.02	0.02
34	0.03	0.03	0.02	0.03
35	0.03	0.03	0.01	0.03
36	0.04	0.04	0.01	0.03
37	0.03	0.04	0.02	0.03
38	0.03	0.04	0.02	0.04
39	0.03	0.05	0.02	0.03
40	0.03	0.04	0.02	0.02
41	0.03	0.02	0.02	0.03
42	0.04	0.03	0.03	0.03
43	0.03	0.06	0.02	0.03

44	0.03	0.04	0.02	0.03
45	0.03	0.04	0.03	0.03
46	0.04	0.03	0.02	0.03
47	0.03	0.03	0.02	0.03
48	0.03	0.05	0.02	0.05
49	0.03	0.05	0.02	0.02
50	0.03	0.04	0.02	0.02
51	0.03	0.03	0.01	0.03
52	0.03	0.05	0.03	0.03
53	0.03	0.02	0.02	0.03
54	0.03	0.04	0.02	0.03
55	0.03	0.03	0.02	0.02
56	0.02	0.03	0.03	0.03
57	0.03	0.05	0.03	0.03
58	0.03	0.04	0.02	0.02
59	0.04	0.04	0.02	0.04
60	0.03	0.04	0.01	0.02
61	0.02	0.02	0.02	0.03
62	0.02	0.04	0.01	0.03
63	0.03	0.03	0.03	0.03
64	0.03	0.03	0.02	0.04
65	0.03	0.02	0.02	0.03
66	0.03	0.02	0.02	0.03
Σ	1.10	2.52	1.42	1.77
AOT	1.10 / 65 = 0.02 min	2.52 / 66 = 0.04 min	1.42 / 66 = 0.02 min	1.77 / 65 = 0.03 min
PR	1.5	1.5	1.5	1.5
NT	0.02 X 1.5 = 0.03 min	0.04 X 1.5 = 0.06	0.02 X 1.5 = 0.03	0.03 X 1.5 = 0.05
TNT	0.03 + 0.06 + 0.03 + 0.05 = 0.17 minute			
AF	• Personal allowance = 5% • Basic fatigue allowance = 4% • Standing allowance = 2% • Unavoidable delay = 0.75% x 14 machines= 10.5% Total Allowance = 21.5%			
ST	= 0.17 / (1 – 0.215) = 0.2166 minute@ 13 seconds			

Table 6 indicates the working calculation involved in identifying the standard time. Element 1 and 4 have one outlier for each. Therefore, the outliers were removed starting from calculating the average observed time (AOT). The AOTs were adjusted to the pace which is 150% for each element, that lead to normal time of 0.03 minute for element 1, 0.06 minute for element 2, 0.03 minute for element 3 and 0.05 minute for element 4. The total normal time (TNT) is 0.17 minute. After adjusting the TNT with 21.5% of allowance factor (AF), it was found that the standard time is 0.2166 minute or 13 seconds. Meaning that, 13 seconds are needed in completing one cycle of honing process.

CONCLUSION AND RECOMMENDATION

This study contributes to operations management discipline by empirically executed the scientific research using observation technique in identifying the standard time. The observations were rigorously conducted in order to meet the hallmark of the scientific research.

There were four objectives to be achieved; to determine the number of observations needed for the study; to determine the average observe time for each element; to determine the total normal time for the honing process; and to determine the standard time for the honing process. All objectives were successfully achieved. There were 66 number of observations needed for the study. The average observed time for collecting and rubbing was 0.02 minute, visualizing was 0.04 minute, checking was 0.02 minute and taping was 0.03 minute. It was found that the total normal time was 0.17 minute and the standard time was 0.2166 minute or 13 seconds. To sum up, 13 seconds is needed in completing one cycle of honing process.

The company should use the calculated standard time for honing process and implementing an effective controlling activity in order to measure the current performance. The operators' responses after using the standard time as the benchmark for the process must be assessed towards continuous improvement.

One of the limitations of the study was focusing on honing section or process only. Therefore, it is recommended to the company to conduct the time study for both semi-automated and labor intensive activities. It would serve as better approach for achieving lean operations. The future research could try to empirically identify the different of performance rating in term of gender and age of the workers, since the different performance rating may adjust the average observe time at different value.

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