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Analysis Work Standardization Using The Standardized Work Combination Table on CNC of Mission Case Line Process at PT Astra Otoparts, Tbk - Nusametal Division

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Abstract. PT Astra Otoparts Tbk. - Nusametal Division is manufacturing company that produce various types of metal part. In the Machining section, there is a new line producing parts of Mission Case. This line has not had the standardized work as an operator's guide in running its production process. Hence, the Standardized Work Combination Table (SWCT) on Mission Case line is created to ensure operator works properly according to the work standard that has been made, to achieve predetermined production, and to prevent product defects. The creation of SWCT resulted in operator cycle time of 151 seconds/3 pcs and 166 seconds/3 pcs for cycle time of machine with operator idle time for 15 seconds that is 2 seconds faster than takt time.

1. Introduction

Standardized work is a very important topic. It is used as a first step towards being lean. Standardized work has developed steadily over many years, it is a topic that has a long history and changed gradually with time [1]. The classical deployment of lean's tools such as standardised work [2], displays the view that standardised work is a classic tool.

PT. Astra Otoparts Tbk. - Nusametal Division has a new line that produces part of Mission Case in the Machining sector, namely Mission Case line. The new line is still in the observation stage, thus standardized work for operator or executor is not yet created. This situation causes operators on the line to work without the standardized work besides the absence of production target achievement and risk of product defect. According to [3] operators have activities based on the production process system, but do not rule out the possibility of operators carrying out other activities that are not in accordance with the work system, which is a loss for the company. The Standardized Work Combination Table (SWCT) is a work instruction that describes combination of human and machine movements in one cycle time, that is describes how the work sequence is done. By looking this table, the order of work and how long the work lasts will be easy to understand, SWCT is also used to find the points needed to do *kaizen* jobs [4]. The step taken to solve this existing problem is creating the Standardized Work Combination Table (SWCT) to determine the standardized work on Mission Case line, thus enabling operators of workers to work according to the standardized work made, achieve the production target, and prevent the production of defective products.



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2. Methodology

The research methodology used in this case uses methods obtained from various references. Motion Study, according to [5], motion study is a method for analyzing various kinds of body movements of workers while doing their job. Motion study analysis aims to eliminate or reduce ineffective movements to become effective ones. According to another expert, [6] motion study is a method to determine the best movement of a person in doing his job.

Kaizen is a method of continuous improvement in a small scale in the production process, quality, operational costs, and job security in a manufacture. Basically, kaizen is one of the continuous improvement methods often used by companies in Japan. The improvement itself means changes made continuously on an existing object and without creating new ones or replacing them [7]. The tools used to do kaizen are standardized work. One of the tools used for standardized work is the combination work standard table [8].

In a brief, steps required to achieve the research objective are as follow:

- Observe the work done and divided it into several motion elements. Motion element are steps to make a standardized from beginning to the end work [1].
- Work measurement is the measurement of work time (time study) of an activity to determine the time required by an operator in carrying out a work activity in normal working conditions and tempo [9].
- Calculate average, min-max mode:

$$\text{average} = \frac{\sum x_i}{n} \quad (1)$$

$$\text{min mode} = \text{the smallest data mostly occur} \quad (2)$$

$$\text{max} = \text{the largest data} \quad (3)$$

- Calculate *baratsuki* [10]

$$\text{Baratsuki} = \text{max} - \text{cycle time} \quad (4)$$
- Determine the classification of motion element [11]
- Motion element with recorded time is classified into value, non-value, and walk.
- Determine cycle time [12]
- Cycle time to be used is determined using the result of min modus calculation for operator cycle time and machine operating time for machine cycle time.
- Determine takt time
- Create SWCT

3. Results and Discussion

Result obtained for step divided observe the work into several motion elements, work measurement, calculate average, min-max mode and *baratsuki* is presented in Table 1 below.

Table 1. Data of work element, work element time, average, min mode and max, and *baratsuki*

NO	WORK ELEMENT	1	2	3	4	5	6	7	8	9	10	Min (Mode)	Max	Average	Baratsuki
1	Take the part before the process (3pcs)	5	6	5	3	4	4	4	4	4	5	4	6	4,4	2
2	Walk to MC 1	2	3	4	2	2	2	1	2	3	3	2	4	2,4	2
3	Cleaning jig and unloading part after operation 2	24	23	24	16	20	17	14	11	15	18	24	24	18,2	0
4	Loading part before + start MC 1	14	14	15	18	10	8	13	13	14	21	14	21	14,0	7
5	Visual check	6	6	10	8	4	5	8	7	5	6	6	10	6,5	4
6	Walk to MC 2	3	3	4	2	2	2	3	4	2	2	2	4	2,7	2
7	Cleaning jig and unloading part after operation 2	22	18	21	14	14	14	16	11	18	15	14	22	16,3	8
8	Loading part before + start MC	14	13	14	12	13	11	7	15	16	12	14	16	12,7	2

2															
9	Visual check	9	6	10	6	3	4	5	5	7	4	6	10	5,9	4
10	Walk to temporary storage	3	3	4	3	1	3	5	5	3	3	3	5	3,3	2
11	Place part in temporary storage	1	1	1	1	1	1	1	1	1	1	1	1	1,0	0
12	Walk to MC 3	3	3	4	7	2	4	3	7	4	9	3	9	4,6	6
13	Cleaning jig and unloading part after operation 2	18	19	20	20	16	15	14	11	20	13	20	20	16,6	0
14	Loading part before + start MC 3	14	13	16	16	11	13	16	15	11	12	16	16	13,7	0
15	Visual check	5	6	5	5	4	5	4	6	5	4	5	6	4,9	1
16	Walk to temporary part after location	3	4	3	3	3	3	3	3	3	2	3	4	3,0	1
17	Pick up part in temporary location	1	1	1	1	1	1	1	1	1	1	1	1	1,0	0
18	Walk to shutter	2	2	2	3	2	2	4	5	4	2	2	5	2,8	3
19	Supply part to shutter	6	7	7	6	7	7	8	7	7	6	7	8	6,8	1
20	Back to the beginning	4	5	5	5	4	4	7	7	4	5	4	7	5,0	3
	Total	159	156	175	151	124	125	137	140	147	144	151	199	145,8	48

Based on Table 1. Cycle time can be determined using the smallest time mode from the time measurement results, which is 151 seconds.

Result of Step 5 is listed in Table 2 as follows.

Table 2. Classification of work element

NO	WORK ELEMENT	Category
1	Pick up part in before process location	Non-Value
2	Walk to MC 1	Walk
3	Cleaning jig and unloading part after operation 2	Non-Value
4	Loading part before + start MC 1	Non-Value
5	Visual check	Non-Value
6	Walk to MC 2	Walk
7	Cleaning jig and unloading part after operation 2	Non-Value
8	Loading part before + start MC 2	Non-Value
9	Visual check	Non-Value
10	Walk to temporary storage	Walk
11	Place part in temporary storage	Non-Value
12	Walk to MC 3	Walk
13	Cleaning jig and unloading part after operation 2	Non-Value
14	Loading part before + start MC 3	Non-Value
15	Visual check	Non-Value
16	Walk to temporary part after location	Walk
17	Pick up part in temporary location	Non-Value
18	Walk to shutter	Walk
19	Supply part to shutter	Non-Value
20	Walk back to before process location	Walk

Result of Step 6 is cycle time for operator is represented by the value of min mode and shown in Table 1, while cycle time for machine is presented in Table 3.

Table 3. Cycle time of machine

No.	Machine	Cycle Time
1	MC 1	126
2	MC 2	126
3	MC 3	126

Data of customer demand/customer need are required to determine takt time in stage 7. Furthermore, the data of customer need is listed in Table 4.

Table 4. Data of customer needs

Data	January	February	March
Quantity (pcs)	13.200	24.000	25.200
Working day	22	20	21
Daily Need	600	1.200	1.200
Working hour	20,75	20,75	20,75
Efficiency	90%	90%	90%

Takt time is determined according to the highest demand data of 1.200 pcs per day. Moreover, calculating takt time is done using the following formula:

$$\begin{aligned}
 \text{Takt Time} &= \frac{\text{Effective time}}{\text{Customer need}} \times \text{Number of machine} \quad (5) \\
 &= \frac{3.600 \frac{\text{second}}{\text{hour}} \times 20,75 \frac{\text{hour}}{\text{day}} \times 90\%}{1.200 \frac{\text{unit}}{\text{day}}} \times 3 \\
 &= 168 \frac{\text{second}}{3 \text{ pcs}}
 \end{aligned}$$

Result of all steps is presented Figure 1 as follows:

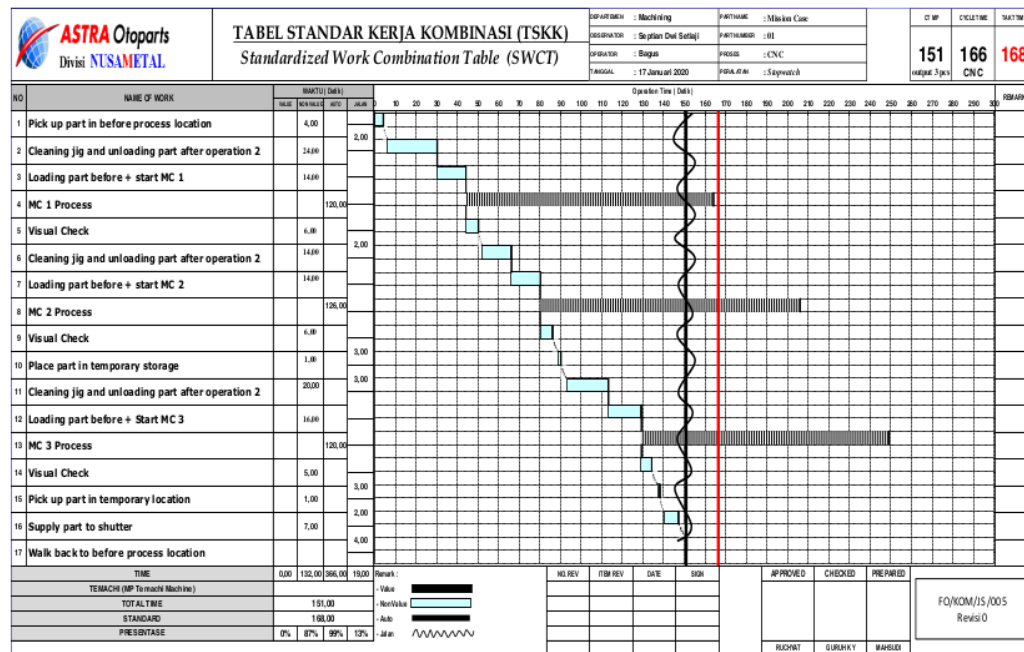


Figure 1. Standardized work combination table (SWCT) of the mission case line.

Figure 1 shows Actual time required by operator to complete work (one cycle) is 151 seconds/3 pcs, while machine takes longer time to complete a cycle (process time + setup time), namely 166 seconds/3 pcs (each machine produces 1 piece per cycle).

Based on the cycle time difference between operator (151 seconds) and machine (166 seconds), it is known that operator should wait for machine to finish operating for 15 seconds in each cycle.

Analysis of Comparison between Takt Time and Cycle Time

In an effort to meet customer demand, company should have smaller cycle time than takt time, thus delay in meeting customer demand will not occur. The cycle time used is machine cycle time since it is the total amount of machine operating time and its loading and unloading time. It is also considered that operator could work within the time and is more consistent. It is known that machine cycle time is 166 seconds/3 pcs, or 2 seconds faster than takt time of 168 seconds/3 pcs.

4. Conclusion

Operator cycle time observed in SWCT is 151 seconds/3 pcs. The cycle time has idle time of 15 seconds due to difference with machine cycle time of 166 seconds/3 pcs. The achievement of this cycle time is stated that the company was able to meet the customer needs of 1200 pcs/day by having time 2 seconds faster than the takt time required, while making the cycle time 166 seconds/3 pcs the standard of work in the mission case line.

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