DESIGN OFIMPROVEMENT TO MINIMIZE MOTION WASTE IN PRODUCTION OF HEADCASING PART AT PT. MULTI INSTRUMENTASI WITH LEAN MANUFACTURING APPROACH

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ABSTRACTPT. Multi Instrumentasi is a manufacturing company that produces water meters. In producing water meters, one of the parts is the head casing. Head casing part consist of two types namely LF-1 and LF-2. Constraints experienced by companies are the inaccessibility of head casing production targets that can hinder the sale of water meters to consumers. For this reason, a proposal to improve the lean manufacturing approach is proposed to minimize the waste that occurs. The stage of the lean manufacturing approach is to identify the production process that occurs using the Process Activity Mapping and Value Stream Mapping. Furthermore, identifying waste that occurs using fishbone diagrams. After identifying waste, waste motion is found in the process of making head casing part with manual lathes. Subsequently, proposed improvements were made using the Single Minutes Exchange of Die (SMED) method. After the proposed improvement, in one month the company can save production costs of Rp 24.000.000 by comparing the existing production costs with after the proposed improvements.

1. PRELIMINARY

1.1 Introduction

Lean Manufacturing is a systematic approach to identifying and eliminating waste, also known as non-value added activities through continuous improvement techniques [1]. The main goal of lean is to reduce costs and increase productivity by eliminating waste. Waste is the types of waste that occur in the manufacturing process or services, namely transportation, inventory, movement, waiting, excessive processing, excessive production, damaged goods [2]. Waste that occurs on the production floor is certainly very detrimental for companies, especially manufacturing companies. Due to the presence of waste on the production floor causes the production process time to be longer and result in product delivery not on time.

PT. Multi Instrumentation is a manufacturing industry company included in the basic metal and electronics industry group. PT. Multi This instrumentation produces measuring equipment namely Water Meter. The company was established on August 22, 1991 and is located on Jalan Tengah Gedebage, Ujung Berung, Bandung. Products manufactured by PT. Multi This instrumentation has a trademark namely "Linflow". Next is main part of water meter compiler at PT. Multi Instrumentation.

1.2 Identification of Problem

PT. Multi Instrumentation produces water meters. One of the water meter parts is the head casing. The problem experienced by companies is the lack of achievement of the company's production targets. To meet production targets, companies buy products from external or commonly called subcontracts. But when buying from a subcontract, you can't buy only part head casings but you have to have a package with a body casing that makes the purchase price soar. The following is a table of production targets compared to the realization of production:

Table 1.1 Target and realization of production

Month	Production Target	Intern Production	Subcontract
First Stock	-	-	8190
January	10800	-	7024
February	12000	-	14975
March	12000	-	7097
April	12000	-	15873
May	12000	-	26110
June	12000	-	3870
July	12000	1460	9795
August	12000	3303	12285
September	12000	5020	13941
October	12000	3977	7460
November	12000	4286	2500
December	12000	4189	7993
Total	142800	22235	137113

2. LITERATURE REFERENCES

2.1 Lean Manufacturing

Lean manufacturing is a systematic approach to identifying and eliminating waste, also known as non-value-added activities through correct continuous improvement techniques. The three factors evaluated for jobs that are considered as added value are:

a. Capacity: Machines, resources, tools, and employees used in the process must have the capacity needed to produce end-value added products.
b. Information / Hints: Employees must know their final product and process to reach the final product with minimum waste or non-value-added activities.
c. Material: Material provided to workers must be free from defects and can be processed and sold in commodity markets. A worker must know which raw material is acceptable or unacceptable. [1]

2.2 Process Activity Mapping

Process Activity Mapping is a diagram that shows the sequences of operations, checks, transportation, waiting, and storage that occur during an ongoing process or procedure. It contains information needed for analysis such as the time needed in a process and the distance of displacement that occurs. [3]

2.3 Fishbone Diagram

A cause and effect diagram also known as a fish bone diagram or Ishikawa diagram. All causes are categorized into different categories such as humans, machines, materials, methods, measurement systems, etc. [4]

2.4SMED

The SMED method is used to speed up the changeover setup time, the result of the improvement achieved is to reduce the time to set up changeover. The following is the SMED procedure:

1. Work in detail
   In the first step, FLM will be displayed and it will occur to determine the dependencies and general categories there. If nothing is transported, it's not too useful to handle the transportation category. In the following cycle, the set-up will be analyzed and explained step by step. Analysis of work steps becomes increasingly detailed.
2. Describe each single action
   The times of each category are then summed up and expressed in relation to the total time. Depending on the requirements, it may be necessary to describe the work step until such a detailed level for conclusions is only a list of the remaining verbs that describe each single action that the process step is made. At some point, further details may not produce additional benefits, but too low a breakdown is a problem when working on a solution.
3. Avoid Aggregation
   The highest level of aggregation will be achieved if it says: "This process is regulated and it lasts for x hours." This is true, but not more than the beginning of the point, where the opportunity was seen reading this book or concentrating on the topic in detail. The reason for this effect to appear is the one mentioned earlier. Loss of supervision because it does not clearly fend off several fields and categories describing the system of sub-aspects in which the entire process can be described. [5]

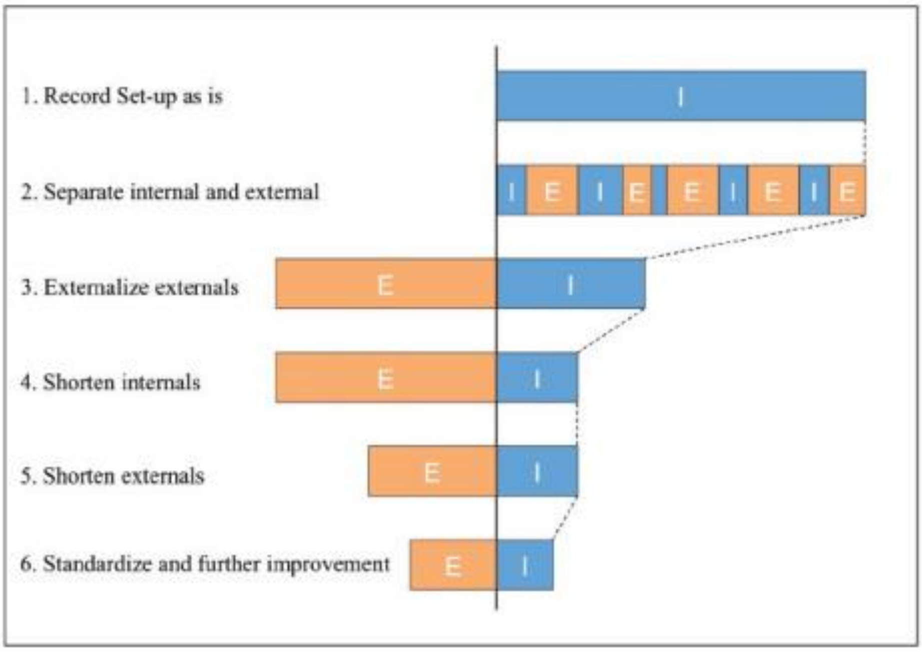

Figure 2.1 Order of SMED work

3. RESEARCH METHODOLOGY

To produce output that is in accordance with the research objectives, a conceptual model is needed which serves to describe the concept of problem solving in a structured manner. The conceptual model that describes the stages through which can be seen in figure 3.1

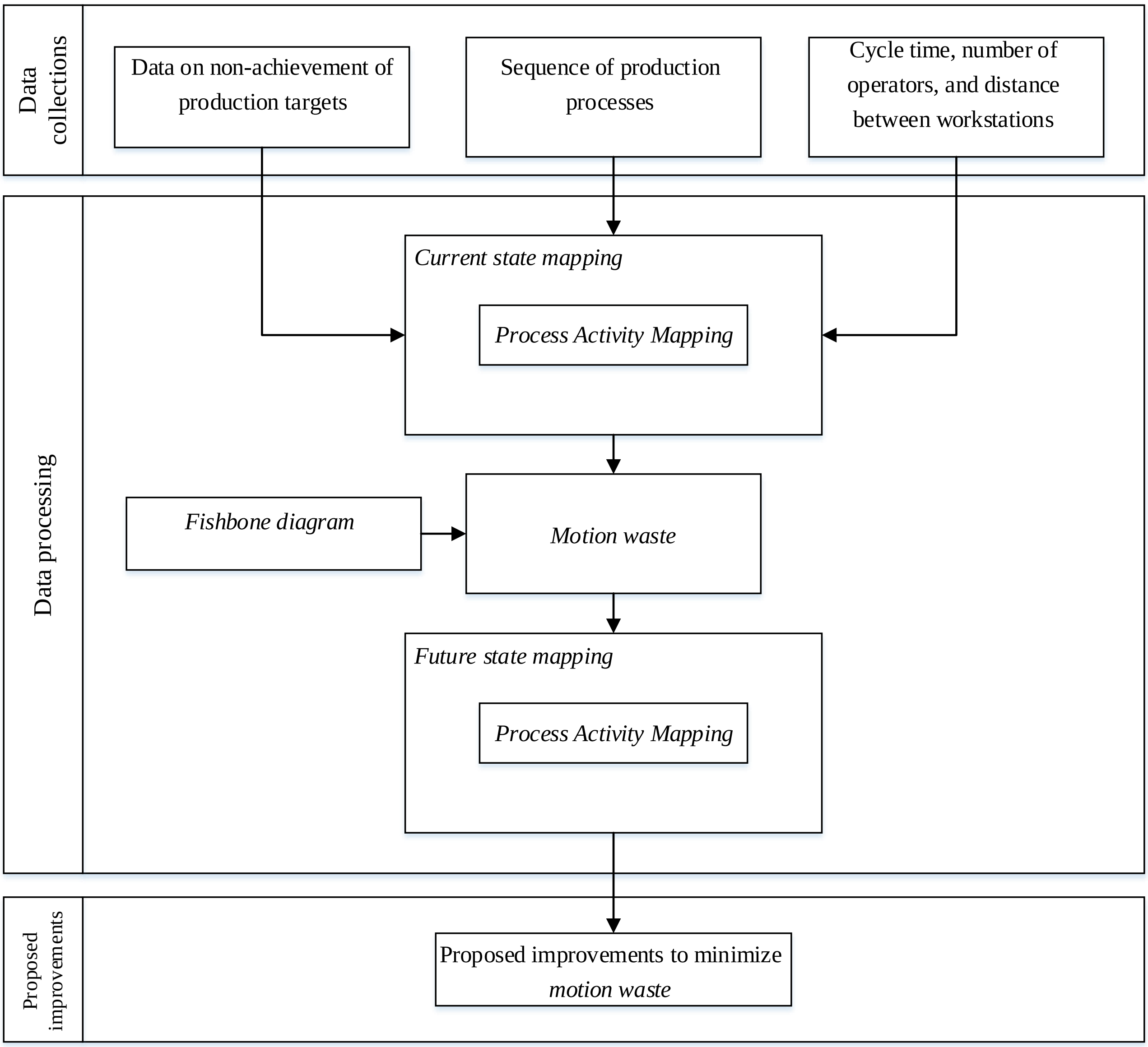

Figure 3.1 Research methodology

4. DATA COLLECTION AND PROCESSING

4.1 Data Collection

Data collection is needed to identify the waste that occurs and provide proposed improvements.

4.1.1 Process Activity Mapping Current State Summary

By using Process Activity Mapping (PAM), activities that include value added, non-value added, and non value added are obtained. The following is a PAM recapitulation:

Table 4.1 Process activity mapping summary

Waste type	time (second)	time (minute)
Waiting	3618,67	60,31
Transportasi	2692,52	44,88
Motion	682,01	11,37

Based on the summary of the process activity mapping above, there are three wastes in the process of making water meters, namely waiting, transportation, and motion waste. However, this study is limited to the discussion of waste motion that occurs in the process of making part head casings.

4.1.2 Looking for the root causes of waste with fishbone diagram

Table 4.2 5WHY'S

Subcause	***Why* (1)**	***Why* (2)**	***Why* (3)**
The screw making process is hampered	Waiting for change tools on manual lathes	Operators look for suitable tools	There is no storage deposit tool

4.2 Processing

4.2.1 Proposed Improvements with SMED

1. Identify activities related to the cycle time that occurred

Table 4.3 Existing activity and cycle time for head casing part schrew making

No.	Existing Activity	Time (seconds)	Internal *set up*	Eksternal *set up*
1	Place the LF-2 worktop type casing	59,80		
2	Go to the storage cabinet to take tools	44,80		
3	Return to the lathe to set up the machine	42,63		
4	Put tools on the work desk	4,89		
5	Take tools and demolition dies	278,24		
6	Place the tools and dies that are dismantled at the work desk	35,87		
7	Towards a storage cabinet picking up new dies	41,45		
8	Look for new dies in the storage cabinet	118,55		
9	Return to the lathe to install new dies	74,90		
10	Take tools and install new dies	357,80		
11	Returns old dies to the storage cabinet	36,09		
12	Place old dies that have been dismantled in the storage cabinet	44,34		
13	Towards the lathe for testing the engine	40,66		
14	Attach the test head casing to the lathe stand	15,39		
15	*Position settings for tools and dies*	118,82		
16	Engine testing process	19,28		
17	Take the casing head test from the chuck	5,50		
18	Checking the casing head of the trial using the vernier caliper	23,57		
19	Installing the test head casing	16,13		
20	*Setting posisi tools dan dies*	114,07		
21	Engine testing process	20,24		
22	Take the casing head test from the chuck	4,55		
23	Check the head casing with Vernier Caliper	22,91		
24	The process of making different types of casing head screws	20,44		
	Total	1560,92	970,46	590,46

2. Make improvement
   a. Merging activities
      Based on the activity set-up table of machines in table 4.2, operators carry out alternating activities to take new tools and then take dies that are located in storage warehouses that have long distances. These two movements can be combined by bringing tools and dies together so that they can save time.
   b. Provision of storage shelves
      Storage racks of tools and dies are provided which are placed next to the manual manual lathe to save time the operator walks to the storage warehouse.
   c. Operator training
      Training is carried out for operators so that the skill increases and can eliminate trial & error activities.Activity and cycle time after improvements

Table 4.4Future activity and cycle time for head casing part schrew making

No.	Initial Activity	Time (second)	Internal *set up*	Eksternal *set up*
1	Place the LF-2 worktop type casing	59,80		
2	Take tools and dies on a storage rack	4,98		
3	Place tools and workbench	4,98		
4	Take tools and demolition dies	278,24		
5	Place the tools and dies that are dismantled at the work desk	4,98		
6	Take tools and install new dies	357,80		
7	Returns old dies to the storage rack	40,02		
8	Install the LF-2 type head casing on the manual lathe stand	15,39		
9	*Position settings for tools and dies*	118,82		
10	The process of making different types of casing head screws	20,44		
	Total	905,45	790,69	114,76

4.2.2 Calculation of production costs per month

Existing :

$$\text{Total production/day} = \frac{Availability\ time - (\ 5\ x\ set\ up\ time\ )}{Cycle\ time} \quad (1)$$

$$= \frac{7\ x\ 3600 - (\ 5\ x\ 1540{,}48\ )}{170{,}11} \quad (2)$$

$$= 102\ \text{part/day} \qquad (2.040\ \text{part/month}) \quad (3)$$

Production cost/month = production realization x intern production cost +
(production target–production realization) x subcontract cost (1)
= 2.040 x 20.000 + (12.000 – 2.040) x 80.000 (2)
= Rp 837.600.000 (3)

After improvement :

$$\text{Total production/day} = \frac{Availability\ time - (\ 5\ x\ set\ up\ time\ )}{Cycle\ time} \quad (1)$$

$$= \frac{7\ x\ 3600 - (\ 5\ x\ 885{,}02)}{170{,}11} \quad (2)$$

$$= 122\ \text{part/day} \qquad (2.440\ \text{part/month}) \quad (3)$$

Production cost/month = production realization x intern production cost +
(production target–production realization) x subcontract cost (1)
= 2.440 x 20.000 + (12.000 – 2.440) x 80.000 (2)
= Rp 813.600.000 (3)

So, in one month the company can save production costs of Rp 24.000.000.

5. ANALYSIS

5.1 Before and After Improvement with SMED Analysis

The table below shows a comparison of set-up time and total production.

Table 5.1 The comparison of set up time & total production before and after improvement

No.	Category	Existing	After Improvement
1.	Set up time	1540,48 s	885,02 s
2.	Total production/day	102	122

5.2 Current State and Future State Process Activity Mapping Analysis

The table below shows the comparison of the current state and future state of PAM.

Table 5.2 The comparison between curren state and future state PAM

Category	Current State PAM (second)	Future State PAM (second)	Reason
Lead Time	22105,54	21450,07	After improvement with SMED, the activity of manual lathe set-up in the process of making part head casing is faster
Value Added	12615,51	7186,14	
Neccesary Non Value Added	5089,21	4972,52	
Non Value Added	4400,82	245,37	

6. CONCLUSION

Based on the explanation above, the company is advised to run the proposal given by the author, because it can increase productivity of head casing part production from 102 part/day to 122 part/day and can decreasing set up time from 1540,48 s to 885,02 s. The proposal above does not require a relatively large cost, only requires operator adaptation in carrying out the design of the proposed activity.

REFERENCES

[1] Franchetti, M. J. (2015). *Lean Six Sigma for Engineers and Managers: With Applied Case Studies*. CRC Press, Year: 2015.

[2] Ledbetter, P. (2018). *The Toyota Template: The Plan for Just-In-Time and Culture Change Beyond Lean Tools*. Productivity Press;Taylor and Francis, Year: 2018.

[3] Iftikar Z. Sutalaksana, Ruhana Anggawisastra, J. H. T. (2006). *Teknik perancangan sistem kerja*. Bandung: ITB Bandung, Year: 2006

[4] Antony, J. (2016). *Lean Six Sigma for Small and Medium Sized Enterprises*. *For Dummies*. CRC Press, Year: 2016.

[5] Herr, K. (2013). *Quick Changeover Concepts Applied : Dramatically Reduce Set-Up Time and Increase Production Flexibility with SMED*. CRC Press, Year: 2013.