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Productivity Improvement using Time and Motion Study at Mixing Work Station PT. XYZ

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ABSTRACT

The domestic plastic manufacturing industry is currently experiencing continuous development. Therefore, competition in the plastics manufacturing industry demands that they are always ready to improve their performance and productivity. PT. XYZ is a plastic manufacturing company that faces problems regarding a lack of productivity levels. There are three work stations at PT.XYZ (Mixing, Injection, and Assembling). The mixing department is the department that has the lowest average productivity percentage, namely 83.3%. Efforts to increase productivity are carried out using an ergonomic approach, namely the time and motion study method and combined with quality tools in the form of check sheets, Pareto, fishbone and 5W+1H analysis. Monika Kussetya Ciptani (2001), the use of the time & motion study method which is integrated with the Activity-Based Costing (ABC) method in terms of cost assignment, will affect the Company's productivity and cost efficiency. From the results of the 5W+1H analysis it is known that the decrease in productivity occurs because there is no standard time measurement for the mixing process. Then there are recommendations for improvement by measuring the standard working time of the mixer operator . In the process of time and motion study analysis it is known that the three elements of the mixing workstation are cleaning the mixer tube, mixing, and packaging. From the calculation results it is known that the normal time is 0.5072 minutes, the allowance is 7.98% and the standard time is 0.5511 minutes. After corrective action was taken, there was an increase in productivity of 16%.

Keywords: productivity, ergonomic, time and motion study

1. Introduction

The plastic manufacturing industry in the country is currently experiencing continuous development, this is in line with the statement of the Ministry of Industry on its website that the potential of national plastic product consumption per capita per year reaches 10 kilograms, this is relatively lower than other ASEAN countries such as Singapore, Malaysia and Thailand which reach 40 kilograms per capita per year (Kemenprin, 2019). Therefore, competition in the plastics manufacturing industry demands that it is always ready to improve its performance and productivity. The highly globalized and competitive market of the 21st century demands to increase high product variety in reducing costs, reducing lead time and perfect quality. This changing scenario requires new manufacturing methods that will enable them to compete in this competitive globalized market (Neha et al., 2013).

Productivity is a measure of economic efficiency that summarizes the value of output relative to the value of the inputs used to create it. There are five factors of production that affect productivity, namely labor, capital, physical resources, entrepreneurship, and information resources (Griffin, 2006). The creation of goods and services requires the transformation of resources into goods and services.The more efficiently we do this conversion, the more productive we will be and the more value is added in the goods or services provided (Heizer, 2015). The meaning of productivity as a ratio between outputs and inputs is a form of productivity measure at the company level or also called micro-level productivity measures (Aroef, 1986).According to Pardede (2007) a productivity is the number of units of goods or services made by a worker in a certain time using various types of machinery and equipment available in the place of work. Productivity is closely related to the company's profit level, productivity is said to be high if with the same or lower resources can produce more products (Syamsudin, 2020).

According to Gaspersz (1998), factors that can affect productivity levels are workplace factors and ergonomics. Workstations are an important part of the industry. Changes in the layout of the production area will increase production output (Soesilo, 2017). Ergonomic workstations are not only needed by large industries, but are also needed to increase the productivity and efficiency of small industries or MSMEs, for example designing ergonomic workstations for Sinar Mutiara MSMEs (Istiyono et al., 2023). Ergonomics is a multidisciplinary approach and can solve the problem of low work productivity, improving the quality of processes and products, and increasing safety and job satisfaction (Iridiastadi, 2014). In addition, the ergonomics approach is also used in various layout designs such as the layout of health examination rooms (Rohimah et al., 2023).

PT XYZ is a plastic manufacturing company located in Tangerang Regency. PT. XYZ faces problems regarding the lack of productivity levels. PT. XYZ manufacturing process consists of three production departments namely Mixing, Injection, and Assembling. In the last The Time and Motion Study method can be integrated with other methods, such as integration with the Activity Based Costing (ABC) method in terms of costing, which will affect the productivity and cost efficiency of the company (Ciptani, 2001). The tools used to support the time and motion study method in this research are check sheets, pareto diagrams, fishbone and 5W 1H analysis.

three months January - March, the productivity reports from the three departments show the results that the Mixing department is the lowest productivity department compared to Injection and Assembling. The average productivity comparison data for January, February, March can be seen in Table 1 below.

Table 1. Productivity Average

Dept.	**Period**			**Prod. Average (%)**
	Jan	**Feb**	**Mar**	
Mixing	86	84	80	**83,33**
Injection	88	89	91	89,33
Assembling	89	90	92	90,33

From table 1 the productivity data of PT. XYZ knows that mixing is the department that has the lowest percentage of productivity.. From the data above, it is also known that the mixing department experiences a decrease in productivity every month. From observations and interviews, the decline in productivity is known from downtime. By looking at the background related to productivity and ergonomics above, researchers conducted research with the theme of Increasing Work Productivity with the Time and Motion Study Method at the Mixing Workstation of PT XYZ.

Time and motion study, as defined by Wignjosoebroto (2003), is a methodical examination of the work system with the goal of creating better processes and procedures, standardizing systems and standards, establishing time standards, and educating operators. Motion study and time study are the two (two) components of time & motion study, according to Mundel (1994). Motion study includes the description, methodical analysis, and creation of work procedures for identifying input materials, output design, procedures, workspaces, tools, and equipment for every stage of a process involving human activity. The time study entails a range of methods to ascertain the duration necessary, using a predetermined time measurement standard, for every task involving machines, people, or a mix of tasks.

Check sheet is a simple designed sheet containing a list of things needed for data recording purposes (Heizer, 2006). Fishbone is a graphical description to analyze potential sources of process deviations that generally come from raw materials (Material), machines (Machine), labor (Man), methods (Method), environment. The use of cause and effect diagrams is to identify the root causes of problems aimed at improving quality improvement (Heizer, 2006). Pareto diagrams are line and block graphs that show how different types of data are compared to the total. The Pareto diagram makes it possible to identify the dominant issue and prioritize the steps necessary to address it. The function of the Pareto diagram is to identify or select the main problems for quality improvement (Juran, 1999). What, Why, Where, When, Who, How (5W1H) is widely used as a management tool in various environments. In any process, improvements can be made by examining aspects of the process (Deming, 1986).

2. Material and Method

The stages in this research are problem identification, determining the scope of the section or department under study, determining the title, data collection, data processing. In this study, primary data collection was carried out by observing and measuring the work process in the Mixing department and interviewing the object to be studied. The interviewees were the mixing operator, admin and mixing supervisor. At the data processing stage, the first step is to calculate the highest amount and type of downtime in the mixing department using a check sheet. The second step is to find out what types of downtime often occur using a Pareto diagram. The third step is to determine the factors that cause downtime so that productivity decreases. The fourth step is to create a problem-solving plan using 5W+1H analysis.

The recommendation results from the 5W+1H analysis are the basis for the time and motion study analysis. The time and motion study analysis begins with the identification of the mixing process work elements, then recording the results of work time measurements, determining the average cycle time (Ws), calculating the normal time (Wn), setting the allowance time (L or Allowance), setting the standard time (Wb), determining the standard time (Ws). The final step is the calculation of the productivity of the mixing department after the proposed improvements. The research steps can be seen in Figure 1 below.

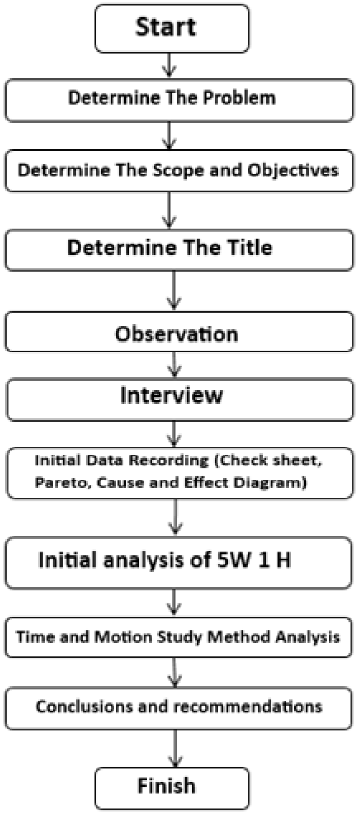

Figure 1. Flow Chart

3. Results and Discussions

The results of this study are as follows: Results of the highest amount and type of downtime in the mixing department. The highest amount and type of downtime in the mixing department shown in table 2 below.

Table 2. Number and Type of Downtime

Period	*Downtime* (hour)		
	Waiting material *mixing*	Different colour	Dirty material
Januari	347	42	9
Februari	461	37	6
Maret	486	28	7
Total	**1294**	**107**	**22**

The results of identifying the types of downtime that often occur. The types of downtime that often occur are displayed in the pareto diagram in Figure 2 below.

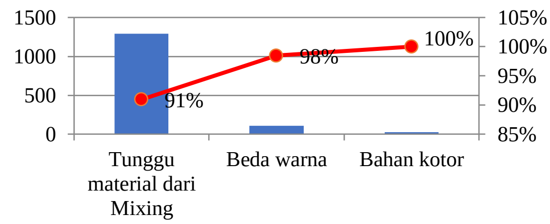

Figure 2. Pareto Diagram of Downtime Types

The results of determining the factors that cause downtime. The factors that cause downtime are displayed in the fishbone in Figure 3 below.

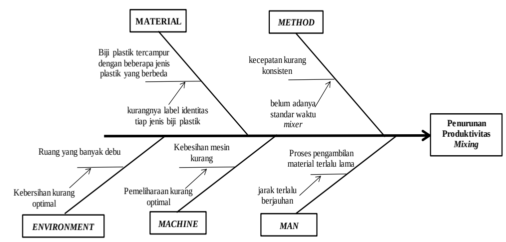

Figure 3. Fishbone for downtime problems

Results of countermeasure plan

Table 3. Problem Management Plan with 5W+1H method

WHAT	WHY	WHERE	WHEN	WHO	HOW
Speed is not consistent	Standard time process mixing not available	Mixing dept. PT. XYZ	April	Leader	Measuring standard time operator mixer

From Table 3 above, it is known that there are recommendations for improvement by measuring the standard working time of the mixer operator. The recommendation results from the 5W+1H analysis are the basis for the time and motion study analysis.

Results of work element identification of mixing process. The time and motion study analysis begins with the identification of the mixing process work elements. The results of the mixing process work element identification are shown in Table 4 below.

Table 4. Mixing Process Work Elements

No.	Work element
1	Cleaning the mixer tube. The operator cleans the mixer tube both inside and outside the tube by washing it with an air duster and soap.
2	Performing the mixing process. The operator mixes pigments and plastic seeds into the mixer tube until they are evenly mixed.
3	Packing the mixing result. The operator unloads the mix into sacks which are then sewn and labeled.

Results of recording work time measurements. After determining the work elements of the mixing process, work time measurements are recorded. The results of recording work time measurements are shown in Table 5 below.

Table 5. Result of Work Time Measurement Recording

No	Process	Average
1	Cleaning mixer tube	331.65
2	Mixing	613.35
3	Packing	134.68

Results of Cycle Time Determination (Ws). After recording the measurement of working time, the next step is to determine the cycle time. The cycle time measurement results are as follows:

The average cycle time for the work step of cleaning the mixer tube (Ws1) is 0.69 minutes.

The average cycle time for the work step of the mixing process (Ws2) is 2.04 minutes

The average Sikus time for the work step of packing the mixing results (Ws3) is 0.44 minutes.

Thus the total Ws = Ws1 + Ws2 + Ws3

= 0.9 + 2.04 + 0.44

= 3.17 minutes

Normal Time Determination Results. After determining the cycle time, the next step is to calculate the normal time. To determine the normal time, cycle time data and Operator Performance Rating are required. From the conversion of the performance rate table, it is known that the operator's performance rate result is +0.16. The results of the calculation of normal time (Wn) are as follows:

Wn = Ws x PR

= 3.17 minutes × (+0.16)

= 0.5072 minutes

Results of Determination of Allowance Time (L or Allowance). After determining the normal time, the allowance time is determined. From the calculation of the percentage of time allowance, it is known that the percentage of allowance (x) is 15.75, so the result of the Allowance Time is:

L = (X/100 x Wn)

= (15.75/100) x 0.5072 = 7.98 %

Standard Time Determination Results (Wb). After knowing Wn = 0.5072 minutes and Allowance of 7.98%, the standard time calculation is carried out. The results of the standard time calculation are as follows:

Wb = Wn x L

= 0.5072 minutes × 7.98 = 4.047 minutes

Standard Time Determination Results (Ws). After knowing the normal time of 0.5072 minutes and Allowance of 7.98%, a standard time calculation is carried out, with the calculation result of 0.5511 minutes.

Results of mixing department productivity calculations after proposed improvements. The last step is the calculation of the productivity of the mixing department after improvement. The results of productivity calculations in April are shown in Table 6 below:

Table 6 Actual production results January – April

Period	***Qty Plan***	**Dept.**	**% Prod**
		Mixing	
Januari	31.500	27.090	86%
Februari	31.500	26.460	84%
Maret	31.500	25.200	80%
April	**31.500**	**30.177**	**96%**
Total	126.000	78.750	

From Table 6 above, it is known that there is an increase in productivity percentage of 16%.

4. Conclusion

The lowest productivity in the mixing department is known from the initial stage of analysis, namely on the fishbone diagram that the cause is from the method factor. After conducting research for three months, namely in January - March with data processing that has been done, it can be concluded that the factor causing a decrease in productivity in the Mixing department is that there is no standard mixer or stirring time. Based on the results of the research that has been carried out the proposed improvements so that productivity in the Mixing department can increase is to measure the standard time of the mixer operator's work. After implementing the proposed improvements in the following month (April), mixing productivity rose 16% from the previous 80% to 96%.

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