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Analysis and Improvement of Production Process Activities of Arikyd 36xx HV Products at PT. Highpolymer Aristek with Manufacturing Cycle Effectiveness and Fishbone Diagram Technique

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Abstract. PT. Aristek Highpolymer is a company engaged in the chemical industry by producing synthetic resins and polyurethanes. In carrying out its business processes, PT. Aristek Highpolymer produces 6 types of products, one of which is arikyd 36xx hv products. In carrying out the production process arikyd 36xx hv there is a delay due to high cycle time that affects effectiveness. With these problems, it is necessary to conduct an analysis of production process activities in order to find the root cause of delays and solutions that are expected to minimize or reduce delays that occur. In this study, the manufacturing cycle effectiveness (MCE) method will be used to be able to determine and improve production effectiveness and identify non-value-adding activities using Fishbone Diagram. From the results of research using the Manufacturing Cycle Effectiveness (MCE) method, the effectiveness of the production process was obtained by 74%, this shows that in carrying out the production process there are still activities not adding value by 26%. Then the root cause of the problem was identified using the fishbone diagram method and it was known that there were 4 main factors that became the problem of non-value added in the production process, namely: Lack of training in production activities, less ergonomic machines and lack of maintenance, Lack of tools in production process activities and inefficient production process layout.

Keywords: Manufacturing Cycle Effectiveness, Effectivities, Fishbone Diagram

INTRODUCTION

In the era of the industrial revolution 4.0 causes no boundaries between countries so that companies have a high level of competition and are required to compete with other companies in the industrial field. Company competitiveness must be created and each company is required to carry out increased effectiveness in the production process, so that the company is able to excel in certain fields compared to similar competing companies. One of the main things that can affect effectiveness in a company is the time of the production process. Production effectiveness is carried out with the aim of producing goods economically, continuously and on time to consumers so that the survival of the company can be guaranteed (Syakhroni, et al. 2019).

In the production process, waste often occurs due to non-value-added activities, such as inspection time, goods transfer time, storage time and waiting time. These non-value-added

activities cause production performance to be inefficient due to waste of production process activities. The production process with a long time causes more resource consumption. In managing activities is the right strategy. The management of these activities focuses on efforts to improve the activities carried out by selecting value added activities that must be maintained and reducing non-value-added activities that are not needed (Khotima, 2021).

PT. Aristek Highpolymer is one of the companies in Indonesia in the chemical industry that produces synthetic resins and polyurethanes. The company was founded in 1991 in cooperation with Korean companies. The synthetic resin market is a very dynamic chemical industry. The activity carried out is to synthesize various kinds of polymers. This company has various types of products, one of which is Arikyd 36xx HV which is used as a solvent for paint mixtures.

Arikyd 36xx hv production process activities, it can be seen that in producing arikyd 36xx hv products there are 17 activities carried out. Starting from weighing raw materials, then checking equipment (if the equipment is appropriate then continue the next process but if the equipment is damaged / lacking then repairs are carried out first) then transfer raw material to the reactor, then set up thermal oil heating (TOH), then reactor heating, then holding temperature, then the alcoholics process, and so on until the transfer of finished good products. In carrying out the production process has a different time in each activity.

In carrying out production activities on Arikyd 36xx HV products, there was a delay. In accordance with the company's target of 1,915 minutes while in fact the production process takes 2,362 minutes. This shows that the production process time does not meet the company's target. The delay is caused because in the production process activities there are still non-value added activities. In the production process carried out by PT. Aristek Highpolymer has non-value-added activities that cause the production process to take a long time. One method to reduce or eliminate non-value-added activities is by applying the Manufacturing Cycle Effectiveness (MCE) method.

Based on this, how is the effectiveness and improvement of the Arikyd 36xx HV production process at PT. Should Highpolymer Aristek do? It is necessary to conduct a study to answer this. So that the effectiveness and productivity at PT. Aristek Highpolymer is achievable.

LITERATURE

Manufacturing Cycle Effectiveness (MCE) is a measure that shows the percentage of value-added activities contained in an activity used by how much non-value-added activities are

reduced and eliminated from the product manufacturing process. All activities, both Value Added Activities and Non-Value-Added Activities, are determined in time measures. Manufacturing Cycle Effectiveness (MCE) is a percentage of value-added activities in production process activities used by companies to generate value for customers. The process of making business products is very necessary for the role of cycle time, which is the entire time needed to process raw materials into finished products. The appropriate production process will produce a cycle time equal to the value of processing time. Determining the measure of production process efficiency can be produced by comparing processing time with cycle time called MCE (Fadhillah, et al. 2021).

MCE analysis can improve company performance and efficiency through improvements aimed at achieving cost effectiveness. Analysis is carried out directly on the activities of the company which are formulated in the form of time data consumed by each activity. MCE is calculated by utilizing the cycle data that has been collected. Cycle time selection can be done by doing activity analysis. Cycle time consists of value-added activity and non-value-added activity. Value added activity is processing time, and non-value-added activity consists of schedule time, inspection time, moving time, waiting time (Sari, 2019).

According to Hines and Taylor (2000) activities are grouped into three groups: first, value added activities; second, non-value-added activities; and third, necessary non-value-added activities. Value added activities are activities that must be carried out to maintain the company. Non-value-added activities are unnecessary activities or activities that are necessary but not carried out efficiently. Necessary non-value-added activities are activities that are still needed in carrying out the production process but do not provide added value to the product (Luluk, 2018).

According to Mulyadi (2007) value added activities are activities that are viewed from the customer's view of adding value in the process of processing inputs into outputs. Value added activities can be created by increasing the quantity and quality of products that are able to meet customer needs. While non-value-added activities according to Emi Rahmawati are activities that are not needed and must be eliminated from the business process because they hinder company performance. Activities that do not cause additional changes in state do not allow other activities to be carried out (Purnamasari, et al. 2018). While necessary non-value-added activities, are activities that do not provide added value to products or services but are needed in existing procedures or operating systems. This activity cannot be eliminated in the short term but can be made more efficient.

Fishbone diagram is a diagram that contains cause and effect or commonly referred to as Ishikawa diagram or fishbone diagram, and cause and effect. Fishbone diagram which is an analytical tool to identify or analyze various causes that have the potential of one effect or problem, then analyze the problem through the brainstorming stage. Fishbone is often used in quality management in the manufacturing industry to identify and classify causes that produce problems (Kristian, 2019).

The steps of making fishbone diagrams are a structured approach that allows a more detailed analysis to be carried out in finding the causes of a problem, discrepancies, and gaps that exist (Monoarfa et al., 2021). There are 6 steps that must be done in conducting analysis with fishbone diagrams, namely: (1) agree on a problem statement which is then interpreted as an "effect" or visually in a fishbone such as a "fish head"; (2) identify the causes of problems that can be grouped into six groups, namely materials, machines and equipment, manpower, methods, mother nature / environment, and measurement; (3) identification of categories of causes interpreted as causes, visually in fishbone such as fishbones; (4) find potential causes where they should be placed in the fishbone diagram, i.e. specify under which category the idea should be placed. The causes are written with a horizontal line so that many small "bones" come out of the diagonal line; (5) Review the sequence of causes until the root cause is found. After that place the root cause of the problem on the branch that corresponds to the main category so that it forms like small bones of fish; (6) reach agreement, after the process of interpretation by looking at the causes that arise repeatedly, agreement is obtained through consensus on the causes, so that the most important and overcome able causes can be selected.

METHOD

This research was conducted in June 2022 at PT. Aristek Highpolymer which is located in Majakerta, Balongan District, Indramayu Regency, West Java 45282. This study uses the manufacturing cycle effectiveness method, to determine company productivity and generate value for customers.

Data collection in this study uses quantitative methods by looking at a problem that occurs based on evidence with observation and measurement of cycle time on Arikyd 36xx HV production process activities and in-depth interviews with the head of production so that exposure to the problem of waste activities in the form of clear and detailed data is obtained. Furthermore, calculations were carried out, comparing and classifying cycle time data

(processing time, inspection time, moving time and waiting time) in the Arikyd 36xx HV production process activities.

The flow of this research starts from literature review, field observation and problem identification, problem formulation and study objectives, data collection, data processing, data analysis and discussion, concluding the results of study findings. The flowchart can be seen in figure 1.

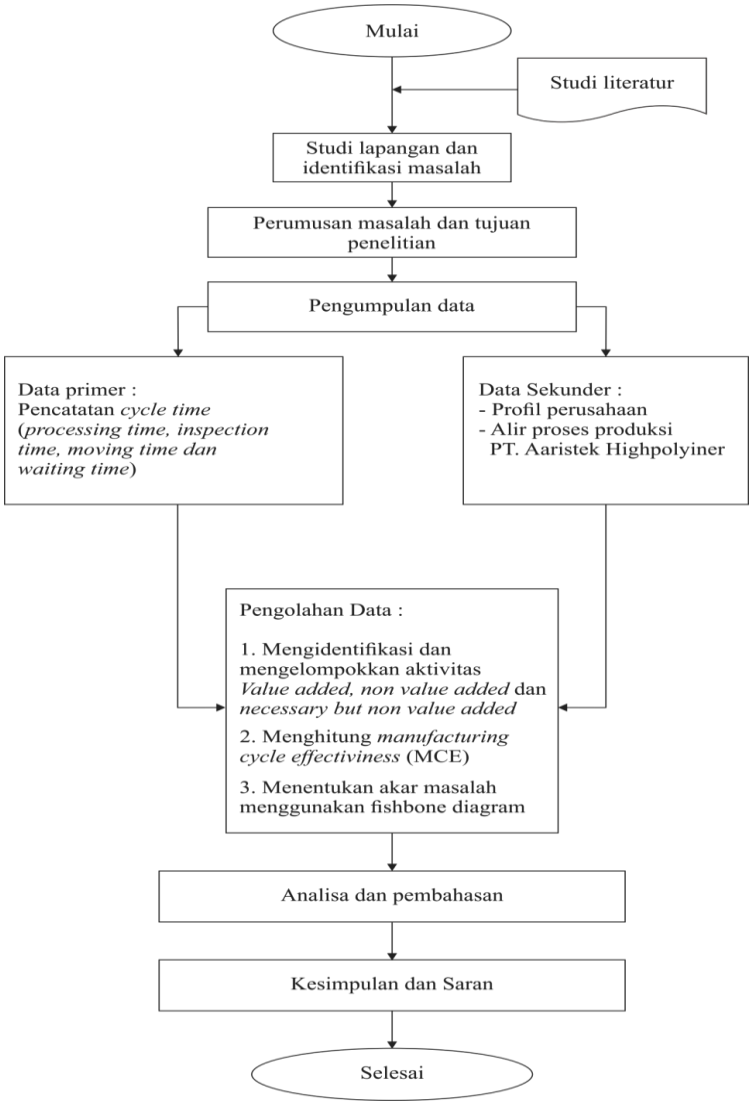

Figure 1. Flowchart Study

DISCUSSION

Target Time in the production process is the time to be achieved by the company in producing a product so that the company can achieve predetermined time efficiency, while time realization or what is often called cycle time is the time to complete the process of a product

starting from raw materials to finished goods both in the machine process and manual work process. Target and time realization in the Arikyd 36xx hv production process can be seen in table 1.

Table 1. Target and Realization of Arikyd 36xx hv Production Process Time

No	Stages	Activity	Target Company (minute)	Reality (minute)
1	Preparation	Penimbangan Raw Material	45	60
2		Cek Peralatan	20	30
3		Transfer Raw Material ke Reaktor	30	45
4		Set Up TOH	45	67
5	Process	Heating Reaktor	250	281
6		Holding Temperatur	60	80
7		Proses Alkoholisis	180	210
8		Cooling Reaktor	60	82
9		Pemasukan Raw Material Tahap B	45	65
10		Heating Reaktor Tahap B	250	272
11		Holding Temperatur	60	75
12		Proses Esterifikasi	300	332
13		Cooling Reaktor	90	120
14	Settlement	Cek Produk by QC	60	85
15		Packing Produk	300	380
16		Label dan Finishing	60	90
17		Transfer Finished Good Produk ke WH	60	88
		Jumlah	1915	2362

Source: PT. Aristek Highpolymer

Based on table 1 of target and realization data, it can be seen that in carrying out the production process arikyd 36xx hv there are 17 activities carried out. These activities have different times in carrying out the process. The company has certain targets in the production process that are carried out based on production calculations in the previous year. However, in carrying out the production process, the targets that have been set by the company are sometimes exceeded. The production process of arikyd 36xx hv as much as 20,000 kg during the January-June 2022 period, the company has a production process target of 1915 minutes, but in reality, the production process occurs for 2362 minutes.

In the process of processing arikyd 36xx hv production process data at PT. Highpolymer Aristek is carried out through 3 stages. The first step is to group production process activities into 3 activities, namely value-added activities, non-value-added activities and necessary but non-value-added activities. The second step is the calculation using the Manufacturing Cycle Effectiveness method to determine the magnitude of the effectiveness of the production process. The third step is to determine the root of the problem through the Fishbone Diagram Method to find out the problems that occur in carrying out the arikyd 36xx hv production process.

Table 2. Overall production process activity

No	Activity	*Cycle Time* (Minute)			
		Processing Time	Inspectio Time	Movin Time	**Waitin Time**
1	Penimbangan Raw Material	4			1
2	Cek Peralatan		2		1
3	Transfer Raw Material ke Reaktor			30	1
4	Set Up TOH	4			2
5	Heating Reaktor	25			3
6	Holding Temperatur	6			2
7	Proses Alkoholisis	180			3
8	Cooling Reaktor	6			2
9	Pemasukan Raw Material Tahap B	45			2
10	Heating Reaktor Tahap B	25			2
11	Holding Temperatur	6			1
12	Proses Esterifikasi	30			3
13	Cooling Reaktor	9			3
14	Cek Produk by QC		6		2
15	Packing Produk	30			8
16	Label dan Finishing	6			3
17	Transfer Finished Good Produk ke WH			60	28
	Jumlah	1745	8	9	447

Source: Processed data

Based on table 2 The overall production process activities can be seen that in carrying out the production process of arikyd 36xx hv products have different times in each activity that occurs. With the time displayed, the entire production time called Cycle Time consists of Processing Time, Inspection Time, Moving Time and Waiting Time. In this first step, the production process activities are grouped into 3 activities, namely value-added activities, non-value-added activities and necessary but non-value-added activities.

Table 3. Value Added Activities

Processing Time	
Penimbangan Raw Material	4
Set Up TOH	4
Heating Reaktor	250
Holding Temperatur	6
Proses Alkoholisis	180
Cooling Reaktor	6
Pemasukan Raw Material Tahap B	4
Heating Reaktor Tahap B	250
Holding Temperatur	6
Proses Esterifikasi	300
Cooling Reaktor	9
Packing Produk	300
Label dan Finishing	6
Jumlah	1745

Source: Processed data

Based on table 3 shows that value added activities are activities that provide added value to products and can provide benefits for the company. VA consists of processing time. In the Raw Material Weighing activity it takes 45 minutes, TOH Set Up takes 45 minutes, Reactor Heating takes 250 minutes and other activities listed in table 4.7 until the Label and Finishing activity takes 60 minutes. So that the total value-added activities (value added activities) amounted to 1745 minutes.

Table 4. Non-Value-Added Activities

Non-Value-Added Activities	
Delay/ Waiting Time	
Total Delay pada aktivitas produksi	44
Jumlah	44

Source: Processed data

Based on table 4 shows that activities are non-value-added activities (NVA), namely activities that do not provide added value to the product or and are not needed in carrying out the production process so that they must be eliminated. NVA consists of waiting time that occurs in production process activities with a total of 447 minutes.

Table 5. Necessary Non-Value-Added Activities

Non-Value-Added Activities	
1. Inspection Time	
Cek Peralatan	2
Cek Produk by QC	6
2. Moving Time	
Transfer Raw Material ke Reaktor	3
Transfer Finished Good Produk ke WH	6
Jumlah	17

Source: Processed data

Transfer Raw Material to Reactor with 30 minutes and Transfer Finished Good Products to WH with 60 minutes so that the total Inspection Time is 90 minutes. With the Inspection Time, and Moving Time, Necessary but non-value-added activities are obtained for 170 minutes.

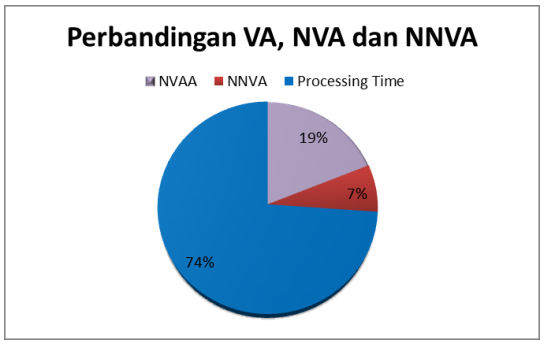

Figure 2. VA, NVA and NNVA Comparison Chart
Source: Processed data

Figure 2 shows the comparison of value-added activities, non-value-added activities and necessary but non-value-added activities. It can be seen that Value Added Activities is 74%, which is 1745 minutes from the total Cycle Time which amounts to 2362 minutes. While Non-Value-Added Activities amounted to 19% with a total of 447 minutes, caused by delayed activities (delay / waiting time). Meanwhile, Necessary but Non-Value-Added Time of 7% with a total of 170 minutes consisting of Inspection Time of 80 minutes occurred in Equipment Check

activities and Product Check activities by QC and Moving Time of 90 minutes occurred in Raw Material Transfer activities to Reactors and Finished Good Product Transfer activities to WH.

In this step, calculations are carried out to determine the level of effectiveness of the production process using the MCE method through a comparison of Processing Time and Cycle Time values. From the calculation of Manufacturing Cycle Effectiveness above, effectiveness in the production process was obtained by 74%. Theoretically, these results show that the level of effectiveness is good enough but still must be improved because the higher the level of production effectiveness will increase productivity. With the production of MCE by 74%, it shows that in carrying out the production process of 20 tons of arikyd 36xx hv products for the January 2022 period, it resulted in value-added activities of 74% and non-added activities of 26% (NVA of 18.9% and NNVA of 7.2%).

Graphically, the percentage that occurs in the production process activity of arikyd 36xx hv products at PT. Aristek Highpolymer can be seen in figure 3.

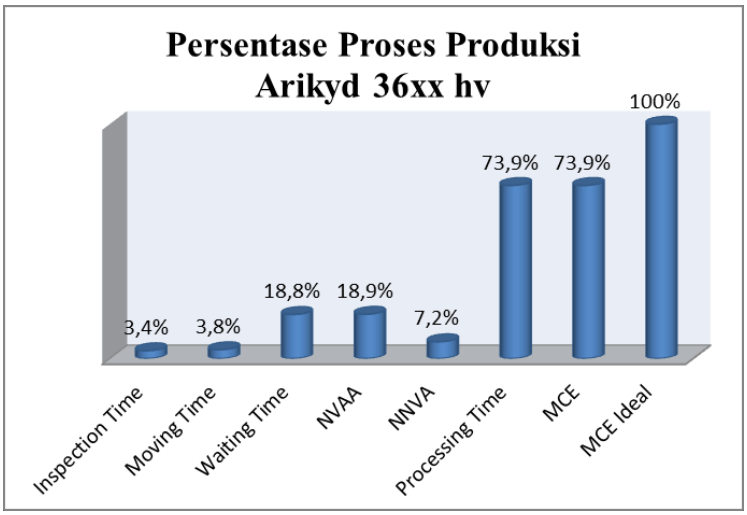

Figure 3. Personates process produces arikyd 36xx hv
Source: Processed data

In Figure 3 The percentage of arikyd 36xx hv production process shows that in carrying out the production process there is inspection time of 3.4%, moving time of 3.8%, waiting time of 18.8%, NVAA (non value added activities) of 18.9%, NNVA (necessary but non value added) of 7.2%, processing time of 74%, MCE (manufacturing cycle effectiveness) of 74% while the ideal MCE is 100%. In this case, the Manufacturing Cycle Effectivenees production process is said to be ideal if MCE=1 or 100%. And vice versa, if MCE < 1, the production process activities still contain non-value-added activities.

By knowing the percentage of non-value-added activities, the next step is to analyze the root of the problem that occurs with the help of Fishbone. To be able to find out the cause of the delay and overcome it, deciphering each element of work is carried out. After the work element that is the focal point is determined, it is determined that the work element that needs to be analyzed first by considering the workstation that has the largest Non-Value Added. Then an analysis process is carried out from all selected work elements by observing and finding out more deeply the root of the existing problems.

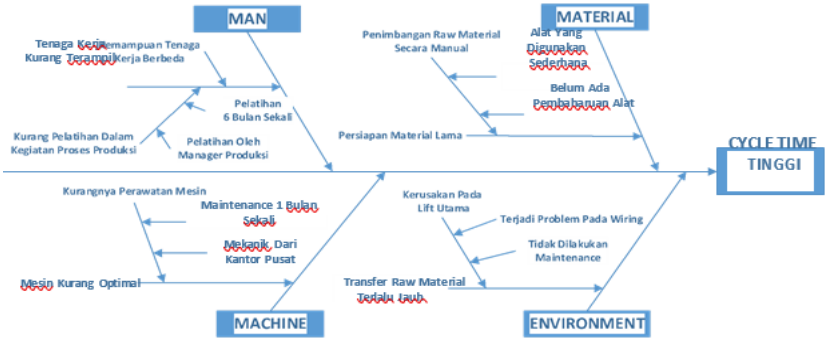

Figure 4. Problems with *Fishbone Diagrams*
Source: Processed data

Based on figure 4, it can be seen that the factors that cause non-value-added activities are in terms of man, material, machine, and environment. In determining the root of the problem that occurs in the production process arikyd 36xx hv is carried out using fishbone diagrams. Based on root cause analysis using fishbone diagrams, it is known that the factors that cause non-value-added activities are in terms of man, material, machine, and environment.

With several factors found, it can be concluded into 4 main factors that become problems with the occurrence of non-value added in the production process, namely: (1) lack of training for employees in production activities; (2) the machine is suboptimal due to lack of maintenance; (3) the weighing of raw materials by the operator still uses simple tools; (4) The raw material transfer layout is too far.

The next step after identifying the root causes of non-value-added activities is to implement improvements to the production process. The proposed improvements are based on four main factors that contribute to the problem, namely: human, machine, material, and layout. The first improvement is to conduct workforce training to enhance the skills and abilities of each worker and to reduce errors and delays caused by human factors. The second improvement is to perform maintenance of production machines to prevent breakdowns and malfunctions that can

disrupt the production process. The maintenance should be done regularly and the machines should be replaced if they are too old or damaged.

The third improvement is to add material handling tools to facilitate the management of goods, such as lifting, transporting, and moving goods. Material handling tools can save time and effort, especially in weighing raw materials, which is done manually in the current process. The fourth improvement is to relay out the production line to make it more efficient and effective. The current layout causes long transportation time, especially in transferring raw materials to the reactor using a backup elevator because the main elevator is broken. The relay out should include fixing the main elevator and minimizing the distance between the production stages.

These improvements are expected to reduce or eliminate the non-value-added activities in the production process of Arikyd 36xx HV products at PT. Aristek Highpolymer. By implementing these improvements, the company can increase the effectiveness of the production process, reduce the cycle time, and improve the quality and quantity of the products. The company can also benefit from lower production costs, higher customer satisfaction, and higher competitive advantage in the market.

CONCLUSION

The research at PT. Aristek Highpolymer shows that the arikyd 36xx hv production process has 74% effectiveness and 26% non-value-added activities. To increase the effectiveness, the problems in the production process need to be analyzed and improved. The root causes of the problems are four factors: (1) lack of training, (2) suboptimal and unmaintained machines, (3) insufficient tools, and (4) ineffective layout.

To increase effectiveness and ultimately lead to productivity, improvement efforts are directed at solving the problems found. Improvements that can be made are by means of labor training, maintenance and rejuvenation of production machines, addition of material handling aids, and relay out of production lines.

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