Lean Manufacturing To Reduce Waste In The Production Process (Pole Posh) Of Guardrail Products At PT.XXX

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Abstract: This study aims to apply Lean Manufacturing to Reduce Waste in the Production Process (Pole Posh) of Guardrail Products. The object of research is the result of the production of posh pole PT. XXX. The approach used in this research is descriptive qualitative approach. Descriptive qualitative research is meant about understanding phenomena that occur in the object of research. The snowball sampling method which is a sampling technique based on interviews or correspondence by asking for information from the first sample to get the next sample until research needs are met, in this study the snowball sampling method is used to select the correspondence at PT. XXX to find out the type of waste that occurs during production process in order to conduct further analysis in this study. Data collection techniques with primary data and secondary data, while data collection techniques with secondary data, observation and interviews. Data analysis technique used Value Stream Mapping.

Keywords: Lean Manufacturing, Value Stream Mapping, Waste

1. Introduction

PT. XXX is a factory that focuses its business in supplying, processing and distributing ready-made steel and concrete plates for the construction, electricity, mining, telecommunications and transportation industries that always trust quality for customer satisfaction. And the focus of this research is Post Pole Production and the following is a flow chart that illustrates the production process at PT. XXX from beginning to end. In the manufacturing industry waste is a phenomenon that is often experienced either natural or production factors, resulting in losses. Based on the situation at PT. XXX in the Production Post Pole in Guardrail Products, it is found that waste affects the production process. Initial analysis of the discovery of waste is made in the form of a questionnaire distributed to staff and heads of production to be able to find the waste that occurs in the company, the results of the questionnaire show that waste with the highest average is waiting. Waiting at PT. XXX in question is like the time used to wait for the material to be used, waiting for the transport of production materials for transfer, waiting for work orders from superiors and waiting time if there are damaged machines that are repaired first so that the schedule that has been set beforehand can change from targets set because of the occurrence of these things. Then waste waiting will be the object of this research, so we can find out how to reduce the waste solution. Efforts made to eliminate waste can provide value to consumers and increase the added value of goods / services in each production in each company (Gazper, 2011). As a result of waste (especially) waiting (waiting time) in each production, therefore a tool or approach is needed so that the waste process can be minimized. Therefore a lean approach is used to reduce waste that occurs in the company. Because waste is the main focus why lean is implemented in manufacturing.

2. Literature Review

Lean Manufacturing

Lean Manufacturing is an ongoing effort to eliminate waste that occurs in an industrial company and increase product value added (Gazpers,2011). Manufacturing principles according there are five basic lean:

1. Indentifying product value based on the customers persepctive, where customers want product of superior quality with competitive prices on timely service.
2. Indentifying the value stream process mapping for each product
3. Eliminating waste that does not add value added
4. Organize so that material , information , products and efficiently along the value stream process using pull system
5. Looking fot various techniques and tools for continous improvement to achieve excellence.

Value Stream Mapping

Value Stream Mapping is the process of making finished goods, including suppliers of raw materials, manufacturing and assembling goods and the distribution network to users of the product. In recognizing the waste the occurs and identifying the causes of waste , the starting point is done using value stream mapping tools , which means that is solving problems starting with the big picture and not just in a single process and improvement is done as a whole not only in the process just certain.

Waste

Waste can be defined as any work activity that does not provide added value in the process of transforming inputs into outpus along the value stream (Gazpers, 2011). There are seven types of waste in the production process (Jakfar ,2014):

1. Transportation
2. Inventory
3. Motion
4. Waiting
5. Over Processing
6. Over Production
7. Defects

3. Research and Methodology

The research method is an approved procedure that is used to answer the research questions that are formulated. Suggestions used in this research are descriptive qualitative. Descriptive qualitative research that discusses the phenomena that occur in the object of research. The snowball sampling method is a sampling technique based on interviews or correspondence by asking for information from the first sample to get the next sample until the research needs are met, in this study the snowball sampling method is used to select the correspondence at PT. XXX to find out the type of waste that occurs during production process in order to conduct further analysis in this study. One method used for implementing lean manufacturing is value stream mapping where this system helps identify value added and eliminate things that do not provide added value in every production. Stages of research arranged in order to solve the problem for the sake of good research results:

1. Conduct a survey to get an overview of the company and what problems will beraised.
2. Conduct secondary data collection
3. Making observations on PT.XXX.
4. Conducting interviews with several parties related to the production process at PT. XXX
5. Creating a Production Process Flow Chart to simplify the process flow systematically and clarify all production activities. Production and operating time data are obtained by direct observation and interviews.

The stages of making Big Picture Mapping are as follows:

1. Collect data needed in the production process.
2. Knowing the achievements and achievements produced by the production system
3. Know the main stages of the production process.
4. Waste Identification.
5. Selecting VALSAT tools by weighting the results of the questionnaire
6. Mapping VALSAT
7. Make an analysis of the results of data processing based on tools.
8. Making conclusions and suggestions from research.

The following is a conceptual that is displayed as follows:

1. Production process
2. Waste problems in the production process
3. Value Stream Mapping (VSM)
4. Waste Solution

4. Result and Discussion

The post guardrail pole production process flow is obtained from interviews with production managers and related machine production operators, this is because the production manager and operator are people who have an understanding of the production process and are directly involved in the production process. The results of the interview were then corrected by direct observation in the field. Based on the results of interviews and direct observations in the field, data obtained from the post guardrail pole production process flow. The post pole production process consists of three main processes, namely:

1. Shearing
2. Punching
3. Bending

Data needed to complete this research are:

1. Post Guardrail Pole Production Process Flow
2. Number of Post Guardrail Pole Production
3. The time of each process in the Post Guardrail Pole production line

The post guardrail pole production process flow is obtained from interviews with production managers and related machine production operators.The results of the interview were then corrected by direct observation in the field. Based on the results of interviews and direct observations in the field, data obtained from the post guardrail pole production process flow. The post pole production process consists of three main processes, namely:

1. Shearing Process
   Shearing process is the process of cutting raw material in the form of a standard size plate with dimensions (6 x 2400 x 1200) mm to post pole dimensions (6 x 1800 x 315) mm. The shearing process is carried out by 2 operators and assisted by 1 helper using a machine Shearing Durma 6m.

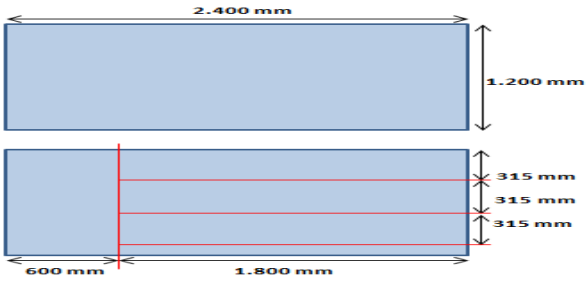

Figure 1. Plate before and after cutting

2. Punching Process
   The punching process is the process of post pillar plate perforation for bolt installation. The post pillar hole consists of a round hole and an oval hole made on the right and left side of the plate. The punching process is carried out by 2 operators and 1 helper using the Cosmec Punching machine.

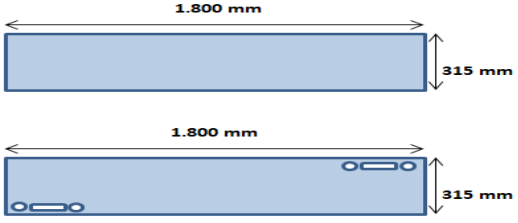

Figure 2. Plate before and after punching

3. Bending Process
   The bending process is the process of bending the plate which has been perforated so that the width dimension of the post pole becomes 171 mm and the bending width of 73mm respectively on the right and left side.

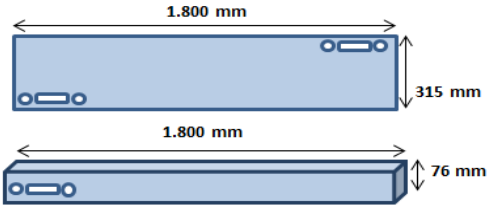

Figure 3. Plate before and after bending

Data on Number of Post Pole Production and Repair / Reject Products in August 2018 - July 2019

Tahun	Bulan	Hasil Produksi (Pcs)		Total Produksi (Pcs)
		OK	Repair /Reject	
2018	Agus '18	6499	58	6441
	Sep '18	6241	50	6191
	Okt '18	5318	43	5275
	Nov '18	7614	53	7561
	Des '18	7013	56	6957
2019	Jan '19	6900	62	6838
	Feb '19	7022	63	6958
	Mar '19	7413	67	7346
	April '19	6574	53	6521
	Mei '19	6263	31	6232
	Juni '19	4691	28	4663
	Juli '19	3390	34	3356
Total Produksi				74339
Rata- Rata/bulan				6195

Table 1. Data on Number of Post Pole Production and Repair / Reject Products in August 2018 - July 2019

Time Of Each Post Pole Production Process

The time of each post pole production is obtained from PT.XXX post pole production capacity data, and then measurements are taken directly to the field to get real time processing data. Production capacity is assumed with normal working hours, which is 7 hours / day.

Post Pole Production Capacity Data :

1. Operator and Helper Shearing Machine - 300
2. Punching Machine Operator and Helper - 200
3. Operators and Helper Benders – 300

Post Guardrail Pole Production Process Flow Data

1. Shearing Process
   The process of shearing or cutting of the plate is done by 2 operators and 1 helper. The first activity carried out is measuring the material manually using a meter, then marked according to the dimensions of the cut (1800 x 315) mm. Material or plate which has been tagged, is lifted to the position of the shearing machine by 2 operators. The weight of 1 sheet of the plate is 27 kg, so it takes a large enough power to lift it. After the plate is in the engine position, the plate will be cut by the Durma 6M Shearing machine. The resulting plate is then transferred by the operator to the semi-finished product area of the shearing machine
2. QC Check (Quallity Control)
   Every material in the semi-finished product area will be checked by a QC (Quality Control) team. The shearing plate will pass the inspection if the cut dimensions are in accordance with the specified dimensions or still meet the tolerance limit of ± 2mm. Plates that exceed the tolerance limit will be grouped into repair / reject products.
3. Material Transfer
   Dishes that have been audited and passed the QC check will be moved to the punching machine area using a hoist cranewhich is operated by 1 helper, then the punching process is carried out.
4. Punching Process
   Puching or punching process carried out by 1 operator and 1helper. The first activity carried out is lifting the material to the position of the punching machine. The plates will be perforated one by one by the Cosmec Punching machine on one side of the plate, then the plates will be rotated manually by the operator so that the other side can also be perforated. When both sides have been perforated (oval and round holes), the plate is then moved to the semi-finished product area of the punching machine.
5. QC Check (Quallity Control)
   Checks carried out in the form of hole size and number of holes resulting from the punching process.
6. Material Transfer
   The plate that has been tapered and passed the QC checking will be moved to the bending machine area using a hoist crane which is operated by 1 helper, then the bending process is carried out. The distance between the punching machine and the bending machine is quite far, so it takes longer to move the plate.
7. Bending Process
   The bending or bending process is carried out by 2 operators. The activity carried out is lifting the plate by the operator to the position of the bending machine. Bending is done on both sides of the plate, so the operator must rotate the plate manually if one side of the plate has been bent.
8. QC Check (Quallity Control)
   The plate that has been bent will be checked by the QC (Quality Control) team, if the degree of bending of both sides of the plate is 90˚, then the product can be categorized as a finished product (OK Product). However, if the degree of bending is less or more than 90˚, it can be categorized as a repair / reject product.

Processing Time Data 15 Post Pillar Samples

No	Pelaksana	Lokasi	Aktivitas	Waktu Rata-Rata (Detik)	Waktu Max (Detik)	Waktu Min (Detik)	post1	post2	post3	post4	post5	post6	post7	post8	post9	post10	post11	post12	post13	post14	post15
1	Operator dan Helper	Mesin Shearing	Mengukur Material	37	49	30	35	37	37	39	35	42	31	36	37	31	36	41	43	35	31
			Marking ukuran Potong	30	39	20	25	27	30	31	30	29	27	28	31	30	32	27	26	29	30
			Mengangkat Material	14	17	12	14	12	13	14	14	14	13	15	17	12	12	15	15	14	16
			Proses Shearing	4	5	3	4	4	4	4	4	3	3	4	4	4	4	3	4	4	4
			Memindahkan Material Hasil Shearing	15	19	12	15	15	16	17	14	12	18	17	16	16	14	13	14	16	17
			Total Waktu Proses Shearing (Detik)				93	95	100	105	97	100	92	100	105	93	98	99	102	98	98
2	Staff Quality Control		Cek Ukuran Pemotongan																		
Transportation & Waiting				480																	
3	Operator dan Helper	Mesin Punching	Mengangkat Material	40	43	39	40	42	42	43	39	39	40	42	42	39	40	42	42	43	43
			Punching Lubang Sisi Kanan	25	27	21	25	25	21	21	24	25	26	24	25	23	23	26	23	23	24
			Memutar Material	18	21	14	18	18	17	16	16	18	18	16	16	14	14	15	16	16	18
			Punching Lubang Sisi Kiri	25	28	22	25	25	26	27	27	26	26	25	27	25	27	27	27	25	26
			Menurunkan Material	15	17	14	15	15	14	17	16	16	15	17	17	17	16	15	15	14	14
			Total Waktu Proses Punching (Detik)				123	125	120	124	122	124	125	124	127	118	120	125	123	121	125
4	Staff Quality Control		Cek Hasil Punching																		
Transportation & Waiting				720																	
5	Operator dan Helper	Mesin Bending	Mengangkat Material	50	60	47	50	51	50	49	49	52	52	49	49	50	51	51	49	50	49
			Teluk Sisi Kanan	4	5	3	4	4	4	5	4	4	4	5	5	5	4	4	4	5	5
			Memutar Material	13	16	12	13	12	12	14	15	14	14	13	12	12	14	12	13	13	12
			Teluk Sisi Kiri	4	5	4	4	4	4	4	4	4	5	4	5	5	4	4	4	4	4
			Menurunkan Material	10	12	9	10	9	9	9	10	11	11	12	9	12	12	11	10	10	10
			Total Waktu Proses Bending (Detik)				81	80	79	81	82	85	86	83	80	84	85	82	80	82	80
6	Staff Quality Control		Cek Hasil Bending																		

Table 2. Processing Time

Value Stream Mapping (VSM)

Value stream mapping is a mapping of the Post Guardrail Pole production process flow

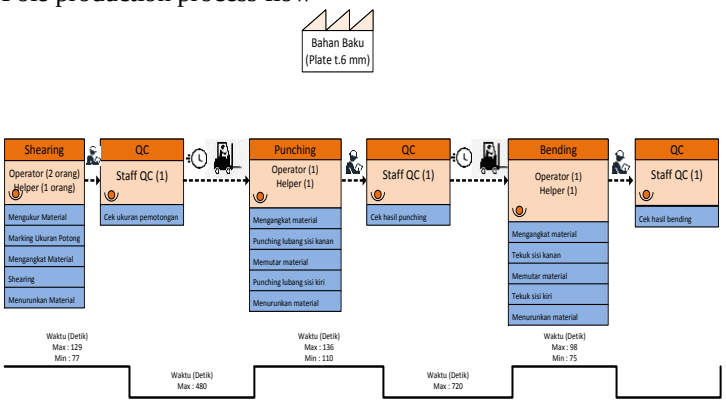

Figure 4. Value Stream Mapping

Fishbone Diagram

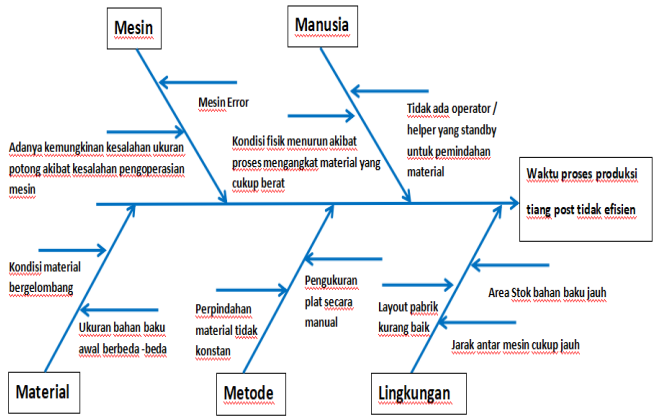

Figure 4. Fishbone Diagram

The cause of the occurrence of the post pole production process is not efficiently eluted through 5 factors.

1. Human
   Humans are the operators involved in the post mast production process. One of the things that causes inefficient post mast production time is the physical condition of humans which is not always stable due to fatigue due to repeated manual work, such as lifting heavy plates. In addition, there is also waste in the form of waiting because there is no standby helper to move the semi-finished material to the next machining process area.
2. The environment
   The environment covers all work areas or post mast production floors. Some of the things that cause material delays are the distance between the warehouse of raw materials to the machine area, and the distance between production machines far enough, so that it takes longer to transport material. In addition, there is no transportation to facilitate and accelerate the process of moving material to the next process.
3. Method
   The method of measuring material manually using a meter can cause waste. Besides requiring longer time, manual measurement is prone to errors. The results are not accurate. Another method that causes inefficient production process time is the method of material transfer in the post pole production process is not constant, meaning that the material will only be moved when the material conveyance is in the area.
4. Material
   The material or raw material used in the production of post masts is a steel plate with a thickness of 6 mm. Initial dimensions and conditions of raw materials vary, so operators must cut dimensions after making measurements. This has an impact on the amount of time needed to make repeated measurements to avoid cutting size errors.
5. Machine
   The condition of the machine is very influential on the results of production. One of the waste that occurs is the condition of the engine that is error so that the machine cannot be operated or the production is not optimal.The causes of waste identified above, can be used as a reference in determining solutions to reduce waste that occurs and the processing time in the production of post masts at PT.XXX.

Based on the VSM and Fishbone previously described, toeliminate or minimize the waste that occurs must be m adesome improvements from all the causes, namely:

1. Human
   Manual removal of material that is carried out continuously causes physical fatigue to the operator, so that production results are not optimal. To avoid this, additional helper is needed so that the material removal process can be carried out alternately so that physical fatigue can be reduced and production results become more optimal.
2. The environment
   Improvements in machine position and factory layout, such as moving the position of the bending machine to an area closer to two other machines (shearing and punching machines), and the addition of conveyors in the form of hoist cranes to accelerate the process of material flow in the production process.
3. Method
   Making jig tables for laying and measuring materials, making it easier for operators to work

faster and reduce physical fatigue for the operator due to uncomfortable work positions. Furthermore, making mall size cut to speed up the measurement process. The mall must be calibrated before by the quality control team so that it can be used to produce products according to specified specifications.

4. Material
   Determination of standard size of raw materials in order to speed up the production process and minimize cutting size errors, and reduce the amount of waste material from the cutting. The recommended standard dimensions are (1800 x 950) mm.

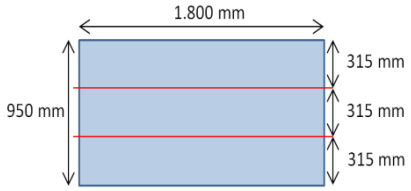

Figure 5. Standard dimensions of plate raw material are recommended

5. Machine
   To avoid errors or damage to the machine that causes the cessation of production or product defects, checking or calibration and regular maintenance is performed on each machine.
   By making these improvements, activities carried out previously can be replaced with activities that are more effective and efficient. This aims to reduce the waste that occurs, especially waiting, motion, and product effect.

Comparison of the process time before repair and the estimated average process time after repair can be seen in table

No	Pelaksana	Lokasi	Aktivitas	Waktu Rata-Rata (Detik)		Kapasitas Pro Hari (Pc	
				Sebelum	Sesudah	Sebelum	Se
1	Operator dan Helper	Mesin Shearing	Mengukur Material	37	26	250	
			Marking ukuran Potong	30	25		
			Mengangkat Material	14	5		
			Proses Shearing	4	4		
			Menurunkan Material	15	5		
			Total Waktu Proses (Detik)	100	65		
2	Staff Quality Control		Cek Ukuran Pemotongan				
3	Operator dan Helper	Mesin Punching	Mengangkat Material	40	37	200	
			Punching Lubang Sisi Kanan	25	20		
			Memutar Material	18	8		
			Punching Lubang Sisi Kiri	25	20		
			Menurunkan Material	15	5		
			Total Waktu Proses (Detik)	123	90		
4	Staff Quality Control		Cek Hasil Punching				
5	Operator dan Helper	Mesin Tekuk	Mengangkat Material	50	37	300	
			Tekuk Sisi Kanan	4	4		
			Memutar Material	13	6		
			Tekuk Sisi Kiri	4	4		
			Menurunkan Material	10	9		
			Total Waktu Proses (Detik)	81	60		
6	Staff Quality Control		Cek Hasil Bending				

Table 3. Comparison of processing time before repair and estimationaverage process time after repair

Based on the above table, it can be analyzed that by implementing the proposed improvements, there are changes in production operating standards in order to increase production capacity and reduce the level of waste.

5. Conclusions

Based on the research results discussed in Chapter IV, this research can be concluded as follows:

1. Production process at PT. Kunango Jantan which is explained through value stream mapping consists of the Shearing process which is the process of cutting raw material post which is then followed by the Punching process which is the process of perforating the post pillar plate for bolt installation and the last is the Bending process which is the process of bending the plate which has been perforated into post pole shape.
2. Based on the results of the distribution of questionnaires about the waste that occurs in the post pole production process at PT. Kunango Jantan, there are 3 wastes that have the highest value, namely waiting, motion (unnecessary movements) and defects (defective products) that disrupt the production process, waste activities that disrupt the production process in the form of :
   a) Waiting: the process of moving material from the first process to the second process can be done if there is a standby conveyance, otherwise the transfer process will be delayed until the conveyance is available so it takes a long time.
   b) Motion: measurement of material and the transfer of material in the area of the production floor of the punching machine to the position of the punching machine which is still done manually, so that it requires more power with a long time.
   c) Defect: due to the two wastes above, some raw materials have been damaged due to the long time waiting and the process is still done manually, so there are still defect products in the manufacture of post masts every month.

The cause of waste that causes the post pole production process is not efficiently traced from 5 factors through the fishbone diagram, namely:

a) Human: a physical condition that is not always stable due to fatigue due to repeated manual work and waste waiting occurs because there is no standby helper to move the semi-finished material to the next machining process area.
b) Environment: What causes material delays is the distance between the warehouse of raw materials to the machine area, and the distance between production machines far enough and the absence of a conveyance to facilitate and speed up the process of moving material to the next process.
c) Method: the cause of waste is the method of measuring material manually using a meter and the method of material transfer in the post pole production process is not constant.
d) Material: Initial dimensions and conditions of raw materials vary, so the operator must cut dimensions after making measurements. Which affects the amount of time needed to do repeated measurements to avoid cutting size errors.

e) Machine: the cause of waste is an error in the condition of the machine so that the machine cannot be operated or the production results are not optimal.

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