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Lean Manufacturing Implementation to Reduce Reject on Part Step Floor with DMAIC and FMEA approach

Muhammad Kholil

Industrial Engineering

University of Mercubuana (Universitas Mercubuana)

DKI Jakarta, Indonesia

ABSTRACT

In this study, the problem is focused on the Cikarang plant, especially department warehouse 5 which is currently producing a new variant, the K2FA type. Because the mass production time for the K2FA type has not been running for a long time, there are still many adjustments that need to be made in the work process in order to create good effectiveness and efficiency. This has not been reflected in one of the supply processes, namely the preparation of the plastic eating step floor, because it was found that there was an additional process, namely the unpacking process and the new preparation train handling facilities which were considered inadequate, causing problems for manpower in the area. This problem begins with the high number of reject parts that reach a total of 11.5% percent in 5 months, therefore the potential for existing rejects must be identified in order to minimize the causes of waste as the goal of this study. The analysis phase is carried out using the DMAIC method (Define, Measure, Analyze, Improve, and Control), and use FMEA improvement analysis (Failure Mode and Effect Analysis). The results of this study are expected to be suggestions for minimizing waste.

Key Words: Define, Measure, Analyze, Improve, and Control (DMAIC), Failure Mode and Effect Analysis (FMEA), Reject, Step Floor.

1. INTRODUCTION

In the current era, the manufacturing industry has grown very rapidly, this is influenced by the increasing demand for local and global markets. In addition, the rapid growth of the manufacturing industry is also influenced by Indonesia's relatively stable political and economic conditions. This makes the behavior of industry players more aggressive with the rampant competition for products through various kinds of innovations to attract the hearts of people in the market today. In the process, the higher demand for local and global markets means productivity will also be higher, with higher productivity, this will affect the difficulty of maintaining the quality of the product, while in order for the product to remain competitive in the market, industry players need to maintain consistency. the quality of the resulting product. Currently quality is important, this is because quality is directly related to public trust in a product issued by a company, where with high public trust it will indirectly affect the purchasing power of the product. In other words, quality is a parameter for consumers in choosing a product. Quality is the ability of a product or service that consistently meets the expectations of consumers. Thus, quality is the only thing that is important to both parties, namely industry players and consumers (1-15).

By implementing quality control, a company can improve and guarantee the quality of the product that will be produced by carrying out several stages such as measuring work results, setting standards, and making corrections between existing standards and the actual process (16-28). Through quality control, it is hoped that the company can increase the effectiveness of control in preventing the occurrence of defective products (defect prevention), so that it can reduce the occurrence of waste in terms of material, time, and labor which can ultimately increase productivity (28-33). In implementing a quality control, it takes a method called Six Sigma. Six sigma itself is a method used to improve quality through reducing process variation and improving process control. In the process, Six Sigma has several process stages which are commonly abbreviated as DMAIC (Define, Measure, Analyze, Improve, and

Control), where in this study the DMAIC method will be used to identify the causes of defects and then carry out data-based problem solving which will later form the output. in the form of gradual improvement, apart from DMAIC, this research also uses the FMEA (Failure Mode and Effect Analysis) method (33-36). FMEA itself is a method used to identify and prevent failure/defects in a product or process. The update of the model from this variant, of course, is also followed by an update on each process and also some of its components. Prior to mass production (Masspro), The company had carried out a series of procedures such as trial and error of each process. The function of this trial and error is to adapt to each actor/department responsible for producing this type of K2FA, as well as eliminating the gap for non-value added activities because it will result in waste (37-38).

Warehouse 5 as one of the actors or the department that functions as a production support team must also adapt to this type of K2FA, one of which is the activity of preparing plastic parts for eatching. In the process of preparing the eatching plastic parts, one of these parts is the Step Floor. The Step Floor preparation process is different from the Step Floor preparation in the previous type, where the K2FA type Step Floor preparation uses material handling tools in the form of a preparation train.

Fig 1 (a) K2FA Step Floor part preparation train, (b) Step Floor part preparation train when filled

During the trial and error process, the engineer decided to make a material handling tool to help the operator of the assy unit, because when measuring the cycle time on the Step Floor section it took longer than the Step Floor assy process in the previous model. The function of the preparatory train here is as a tool to reduce the cycle time of the operator assy unit during the assembly process. However, this actually has a negative impact on the preparation operators in the warehouse. The negative impact in question is the emergence of a high enough intensity reject on the Step Floor part and the reduced quantity of preparation due to the inaccurate design of the new Step Floor preparation train. In addition, as shown in Figure 1.1 (b) it can be seen if there is a potential for the part to fall and be hit by the operator when the train is filled with Step Floor parts due to the high pile.

From these problems, the warehouse collects Step Floor reject part data starting from the mass production period, namely August 2021 to December 2021 as shown in the following table:

Table 1. Total Production and Total Reject Part Step Floor.

No	Month	Total Product	Reject Variant				Total Reject	Reject Percentage
			Strach	Broken	Cli	Fade		
1	August 2021	1200	92	71	63	9	235	19.6%
2	September 2021	1900	103	93	35	1	232	12.2%
3	October 2021	2200	104	90	21	2	217	9.9%
4	November 2021	2200	111	74	25	0	210	9.5%

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No	Month	Total Product	Reject Variant				Total Reject	Reject Percentage
			Strach	Broken	Cli	Fade		
5	December 2021	2200	102	95	18	0	215	9.8%
	Total	9700	518	423	162	12	1115	11.5%

From table 1 it can be seen, the warehouse recorded that there were around 11.5% rejects from the total production or more precisely there were 1115 rejects which were categorized as visual and functional defects with the types of defects being broken, scratched, faded, and wrong clip. This indicates a deviation, because the management set the tolerance limit for damage or rejects is 5% for each part per month

Table 2. Classification of types and number of Step Floor reject parts

No	Reject Type	Total Reject
1	Scratch	518
2	Broken	423
3	Faded	12
4	Wrong Clip	162

From table 2 it can be concluded that if there is a need for improvement to minimize the potential for rejects that occur in the Step Floor part. To analyze and overcome these problems, the DMAIC and FMEA methods are used in the hope of achieving a product defect level close to zero defect.

2. RESEARCH METHOD

After collecting data, it will proceed with processing the data. The following are the steps involved in data processing:

1. DMAIC method.

The stages in this method are:

a. Define

At this stage the SIPOC diagram is used to define the key processes in the supply warehouse process to production. The key process in the supply part is focused on the preparation of the Step Floor part. From the SIPOC diagram, it is obtained CTQ (Critical to Quality) rejects for each process.

b. Measure

In this stage, determine the dominant type of defect which is CTQ (Critiqal to Quality) using a Pareton diagram and then measure the value of DPMO (Defects per Million Opportunities) and SQL (Sigma Quality Level) values. Furthermore, the DPMO value is converted to the Six sigma conversion table to determine the sigma level. The steps required are as follows:

1. Calculation of Defects per Opportunities (DPO)

It is a measure of failure that shows defects one at a time.

2. Calculation of Defects per Million Opportunities (DPMO)

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A measure of failure that shows the number of defects per million opportunities.

3. Finding the Sigma Quality Level (SQL) value

It is an indicator that describes the level of process performance, and to find the sigma value, and can be continued by calculating the yield process by calculating the defect value per unit (DPU).

c. Analyze

At this stage is the stage of analyzing, seeking and finding the root cause of a problem, in this study it is the root cause of the rejection of the Step Floor part. This can be analyzed using a fishbone diagram. To find out the cause of rejection through Man, Machine, Material, Method, and Environment factors.

d. Improve

At this stage, FMEA (Failure Mode and Effect Analysis) is used to determine the priority of the improvement plan. FMEA is a systematic of activities that identify and evaluate the level of potential failure that exists in a system, product or process, especially at the roots of the product or process function on the factors that affect the product or process.

The purpose of FMEA is to develop, improve, and control the probability values of the failure detected from the source (input) and also to reduce the effects caused by the "failure" event (34). Each type of failure has 1 (one) RPN (Risk Priority Number), which is the result of the multiplication of severity, detection, and occurrence ranking. Then the RPN is sorted from the largest to the smallest, so that the most critical types of failures can be identified which are the priority for corrective action (23).

e. Control

At this stage the implementation of new work standards needs to be implemented and controlled as optimally as possible so that quality control does not decrease in performance as management changes in the company. This control is carried out by monitoring related areas by looking at monthly reject data.

3. RESULT

Define stage

At this stage, namely the define stage, the tools to be used are SIPOC diagrams. After making the SIPOC diagram, then identifying the process related to the Step Floor part preparation process, then CTQ is determined based on the process identified as having the highest number of potential defects.

Based on the SIPOC diagram, the unpacking process up to the transfer of parts to the preparatory train resulted in the 2 highest rejects, namely broken and scratched. Where these 2 types of rejects are used as CTQ because they have a dominant number than other types of rejects.

Stage Measure

At the measurement stage in this research, it is done by calculating DPMO (Defect per Million Opportunities) and determining the sigma value (SQL). Based on the production data and reject data for 5 months, the results of the calculation of the DPMO value and sigma level are as shown in table 4.3 where the average DPMO value is 57664.1 and is at the sigma level of 3.08. Based on the results obtained, it shows that the quality control carried out still has to be improved considering that the average sigma value of manufacturing companies is 4.00 and is still far from the target of improving the quality of six sigma, which is reaching sigma level 6.

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Analyze Stage

- Pareto chart

Pareto diagram is a tool used to find the cause of a problem or damage to a product by getting the highest damage data and to be able to focus repairs on the most dominant problem. In addition to analysis using Pareto diagrams, Pareto diagrams are very important because they are useful in determining the main problems faced so that problems can be solved effectively and efficiently.

Based on the Pareto diagram, there are 4 main types of rejects that are being faced by warehouse 5, namely scratches, fractures, wrong clips, and faded, and according to the results of the Pareto rejects, the dominant ones are scratches and fractures. Scratch rejection has a percentage of 46% and a broken reject has a percentage of 38%. After knowing the dominant reject on the Step Floor, the next step is to focus on identifying the causes of scratch and fracture rejects through the fishbone.

- Fishbone Charts

Because there are 2 types of dominant rejects, further analysis is carried out to find the root cause of the problem using a fishbone diagram based on each type of reject

Based on the fishbone diagram, there are 2 factors of scratch rejects and broken rejects. The following is a description of the explanation of the 2 fishbones:

c. Fishbone diagram (reject scratch)

- Human factor

In this factor, the reject occurs because of an additional process, where the current state of preparation for the Step Floor requires an unpacking process, namely the process of moving parts from the supplier box to the train. This indirectly causes Manpower to have an increased workload, besides the presence of handling facilities in the form of trains is considered less than optimal, because with a smaller capacity of 50pcs per train, Manpower has to do more and faster preparations than before to meet assembly needs. . With this condition, the operator will feel more tired than usual which may lead to negligence such as the arrangement of parts on the train falling apart which may later become the cause of potential rejects plus ignoring the existing SOPs.

- Method factor.

This factor is a continuation factor of the human factor where the method of preparation for this type of K2FA is different from the previous one, where there are additional processes such as the process of unpacking parts from the supplier box to the preparation train. With the current situation, where the delivery of parts to the assembly is fast and the man power is not careful in treating the parts, these things have become the potential for scratch rejects during the unpacking process itself. In addition, there is a situation where the train preparation is inadequate, which is inadequate here. What is meant by the quantity on the train identity label is 50, but after packing 50, the condition of the parts on the train towers like overpacking, so that the parts often fall.

d. Fishbone diagram (broken rejection)

- Human Factor

Due to additional work processes, as previously mentioned, namely inadequate trains and unpacking processes, the cycle in the automated preparation process must be demanded to be faster. This causes the operator to be less careful and lead to the placement of parts that seem forced.

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- Method factor.

With the current state of affairs, the existence of a handling facility in the form of a preparatory carriage is deemed insufficient to maximize the manpower requirement in the plastic eatching preparation area in carrying out the supply process to the assy. Of course there are several reasons, including inadequate trains, less quantity than the previous carriage, the placement of parts seems forced because the dimensions of the train are not relevant to the dimensions of the 50pcs Step Floor part.

After that proceed to the improve stage with analysis using FMEA to find out improvement activities based on the RPN value with the aim of finding recommendations for improvement based on the greatest priority.

Improve Stage

The next stage is the Improve stage using the FMEA (Failure Mode and Effect Analysis) tools to determine which are the priorities for improvement by looking at the largest RPN value in the FMEA table. At this stage, the priority of improvement is determined by improving with the FMEA (Failure Mode and Effect Analysis) method. FMEA is a method used to identify and evaluate the level of failure that exists in a system, where the system referred to here is focused on the supply system,

Based on the RPN value, it can be seen that the 3 biggest problems are, manpower is not careful with the RPN value of 280. This factor occurs because of the inadequate condition of the train and the preparation pattern that seems faster than before so that man power only focuses on making preparations without paying attention to conditions. parts. Then there is an additional process (unpacking process), with an RPN value of 252, this factor occurs because there is an additional process without being followed by changes relevant to the preparation process and finally the train is not adequate, with a value of RPN 225. As previously mentioned, the train preparation for parts The current step floor is not optimal in terms of dimensions and function and seems to make the preparation process difficult. After knowing the suggestions for corrective actions in FMEA, it is necessary to have a controller or supervision to control or supervise quality control in the preparation of Step Floor in warehouse 5.

Control Stage

The final stage of the six sigma stage, this stage is a stage that serves to monitor the results of improvements rather than the improvements made, to ensure and see whether the improvements provided are going well or not. To ensure this, at this stage a simulation of the proposed improvements in the FMEA table is carried out, especially to reuse the old method for Step Floor preparation.

In order to ensure that the old method is effective or not, control is carried out with the initial goal of reducing the potential for rejects. This is done through monitoring within a certain period and by looking at monthly reject data.

Process control is carried out in several ways:

1. Reusing the old SOP, namely the SOP for the preparation of the Step Floor part.

This SOP aims to minimize the potential causes of rejects in the preparation of Step Floor parts that can occur due to inadequate new trains and the unpacking process that takes more time. The SOP that must be followed is using a universal train, so that Manpower no longer needs to carry out the unpacking process and use a new train that is inadequate. Then after the old SOP (method) was carried out, control was carried out by seeing whether there were still many defects due to the plastic eating process after the repair. Apart from the proposed improvement focusing on reusing the old SOP, the warehouse agreed to abolish the unpacking process because it was too time-consuming for the process and to return to using the universal train. With this SOP, it is hoped that later it can reduce defects in the preparation of Step Floor parts so that productivity in the preparation process increases.

2. Make a monthly monitoring reject Step Floor checksheet.

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The monthly Step Floor reject monitoring checksheet is made to ensure the old SOP (method) resulting from the proposed improvements in the FMEA table is functioning or running well, which can minimize the potential for rejects in the Step Floor part. In addition, this checksheet functions as a documentation medium in order to know the progress and history of rejects on a regular basis.

4. CONCLUSION

Based on the processing and analysis of the supply process at the Step Floor preparation stage in warehouse 5, the following conclusions can be drawn:

1. Various types of rejects were identified in the supply process at the Step Floor preparation stage in warehouse 5, including broken, scratched, faded, and wrong clip items.

2. The Pareto diagram analysis revealed that the dominant types of rejects were broken and scratched items. The fishbone analysis identified human factors and methods as the main causes of fractures and scratches in the Step Floor part of warehouse 5. Insufficient train handling facilities and the unpacking process leading to rushed work were contributing factors.

3. The DMAIC analysis was conducted, followed by improvement using FMEA. The proposed improvement involves reverting to the old SOP (method) of preparation, which utilizes a universal carriage without the need for the unpacking process. Additionally, clear directions will be provided to the manpower based on the applicable work instructions.

By implementing these improvements, it is expected that the occurrence of broken and scratched items in the supply process at the Step Floor preparation stage in warehouse 5 will be significantly reduced.

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C. Author: muhammad_kholil@mercubuana.ac.id

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