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Analysis of Defect Door: A Case Study In Appliance Product with DMAIC Approach

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Abstract:- This research is case study in the product appliance company. The case study is door damage that defect abnormalities. The research method used is the DMAIC approach. From the stages of DMAIC (Define, Measure, Analysis, Improve, Control). Activities starting from identifying problems, measuring data from the factors that influence, analyzing the factors that influence it, followed by submitting improvement ideas and finally controlling the improvements that have been made.

From the results of the case studies carried out there are 4 factors that influence the quality of the door damage consisting of insufficient material (inner door hole), density of the urethane pattern material which is quite low, the stability dimensions of urethane material that are too high, inspection methods includes all inspection items.

Keyword:- *DMAIC, Study Case, Door Defect.*

I. INTRODUCTION

Consumers are an important element for a manufacturing industry. Consumers can be likened to the life of the sustainability of a company to continue to grow. So important is the meaning of consumers that manufacturing companies in various ways try to fulfill whatever they want, needed by the manufacturing industry consumers to meet their needs and satisfied consumers. Six Sigma is a formal and highly disciplined methodology for reducing process variation to ensure customer satisfaction, cost reduction and profitability of the organization Srinivasan et al., (2014).

According to Purba & Aisyah, (2017) consumers are very central parties in business transactions, products or services. The survival of an organization or company depends on the customer. The importance of consumers or customers for a company so that in various ways try to how to meet customer or customer satisfaction through products or services (services) by fulfilling consumer desires by analyzing factors that can be developed to increase the value or value of the product or service (services) so that the market has the potential to respond positively.

Customer satisfaction is the level of one's feelings after comparing performance or the results he feels compared to his expectations, customer satisfaction as an emotional response to the evaluation of the consumption experience of a product or service. The level of consumer satisfaction is determined by the size of the gap between consumer expectations and the reality of services received by consumers. The greater the gap between expectations and reality received by consumers, the greater the consumer's dissatisfaction with these services. Consumer dissatisfaction with a service because it is not in accordance with what is expected to have a negative impact on the success of these services. If this gap is not anticipated, it can lead to a failure in marketing goods or services. According to Linder man in Zu et al., (2008) Six Sigma applies a structured approach to managing improvement activities, which is for improving process by Define–Measure–Analyze–Improve–Control (DMAIC) or For improving product /service design by Define–Measure– Analyze–Design–Verify (DMADV).

Consumer dissatisfaction with a service because it is not in accordance with what is expected to have a negative impact on the success of these services. If this gap is not anticipated, it can lead to a failure in marketing goods or services. Quality is one indicator of the fulfillment of the needs and needs of the consignment in addition to the price and accuracy of delivery. The higher the level of quality provided by the company to consumers, the higher the level of customer satisfaction. Tjiptono & Diana, (2003) states that quality is a dynamic condition that relates to products, services, people, processes, and environments that meet or exceed expectations.

In current situation, the quality of the appearance of the appliance products, especially the door that have been produced, has a slight problem. The problem that occurs is that there is abnormal of door. The thing that is quite a concern is the occurrence after usage at the customer. Of course this will have a very serious impact because surely consumers feel disappointed because of the disability.

II. LITERATURE REVIEW

Six Sigma comes from Six which means six (6) and Sigma which is a unit of standard deviation which is also symbolized by the symbol σ, Six Sigma is also often symbolized as 6σ.Sigma is a symbol of standard deviation in statistics (Σ or σ), is a measure for expressing variance, or inaccuracy of a group of items or processes. The purpose of Sigma is to reduce variation in output so that it will not

exceed six standard deviations (Sigma) between the nearest mean and limit of specifications. “Sigma” is a notion taken from statistics. It means any standard deviation of the random variable around the mean value. Therefore, Six Sigma means six times the distance of standard deviation (Smętkowska & Mrugalska, 2018).

Sigma processes must be able to produce errors of less than 3.4 per one million opportunities (per million opportunities) or reach 99.9966% success rate. Antony on Sahoo et al., (2007) stated that from the view of statistics, this concept can be defined as a goal set for limiting the process variability within ±6σ (i.e., total spread of 12 σ) which leads to 3.4 defects per million opportunities (DPMO) for any process (Sigma or σ = standard deviation on the normal distribution).The higher the sigma value, the less a process experiences variations and the fewer errors that will be experienced. Six Sigma Implementation focuses on processes, both in the production process or service. When achieved, Six Sigma will be able to ensure that the entire production process runs at optimal efficiency Implementation. Of the many understandings above, it can be simplified into one complete and clear definition, namely: Six Sigma is a system that is comprehensive and flexible to achieve, provide support and maximize business processes, which focus on understanding customer needs using facts, data, and statistical analysis and continuously pay attention to arrangements, improvements and review of business processes.

The advantages of applying Six Sigma are different for each company depending on the business that is carried out, the vision and mission and strategy of the company concerned. But generally with the application of Six Sigma there will be improvements in the following matters:

1. Cost reduction
2. Growth in market share
3. Reduction of cycle time
4. Customer retention or customer loyalty
5. Reduction of errors in defective products or products
6. Changes in work culture
7. Development of products or services

The most commonly used Six Sigma approach is DMAIC (Define, Measure, analyze, improve, control). There are three basic qualifications that must be met to use the DMAIC method, namely:

1. There is a gap between current and expected performance. First of all it is necessary to determine what problems must be solved, or what opportunities will be achieved. In the case of process design, a new activity is launched where no process appears.
2. The cause of the problem is not correctly understood. Management may only understand problems theoretically, but do not know the root cause of the problem.
3. The solution has not been established. If management has planned short-term changes, there is still time to implement Six Sigma. Six Sigma applications can quickly save time for more accurate analysis. If a significant effort has been made to bridge the gap, the application of Six Sigma will not be useful.

Costa et al., (2017) By implementing several improvement procedures resulting in a decrease of 0.89% on indications of work produced by the production system in the rubber extrusion process of two semi-tire products. Pugna et al., (2016) Creative solutions for repairing process assembling in automotive companies are obtained by using statistical thinking methods and the DMAIC six sigma method. Jevgeni et al., (2015) With the integration of various tools and the Six Sigma method DMAIC, FMEA, TOC, TC, Swim-line degree can reduce production lead time and increase production output with little expenditure. De Mast et al., (2012) The DMAIC method is a method that is not only suitable but also provides an identity if one is ineffective.

- *Define*

It is the first stage of the DMAIC process, this stage aims to unite opinions about the activities to be carried out, both the scope, objectives, costs and targets of the activities to be carried out.

Stages in Define:

1. Determine the repair team
   Form a team consisting of all stage holders who are related within the scope of the company.
2. Determine the activity plan
   Make detailed activity plans and be known by the related stage holder.
3. Determine the scope of the project
   The project scope is used to identify parties related to the project and will feel the impact of the project. To find out the project scope, use the SIPOC diagram.
4. Collect data on VOC (Voice of Customers)
   Data collection of VOC (Voice of Customers) or customer desires for the products produced.
5. Review the Define stage

- *Measure*

Aim to find out the process that is going on, collect data about the speed of the process, the quality and costs that will be used to find out the cause of the real problem. Stages on Measure:

1. Determine the output and input of the process
   At this stage the input and output processes are clearly identified.
2. Determine the performance measure used
   At this stage, the determination of performance measures will be used to analyze the process. This measure of performance will be used to show the system performance both the system before repairs and after repairs.
3. Perform data collection for calculations

Collection of all data that will be needed to perform calculations in the measure stage
4. Calculate process capability Calculation of the initial capability of the process or commonly called the baseline capability. This capability will be the benchmark or basis for improvement.
5. Review the Measure stage.

➢ *Analyze*

Analysis is to verify the causes that affect key input and key output.

Below is the stages in analyze:
1. Determine critical inputs. Determining the location of problems that occur in each process at the production.
2. Perform data analysis and process analysis. At this stage an analysis of the data that has been obtained and the process that occurs in more detail. This stage aims to find out what is the root cause of the real problem.
3. Determine the root cause of the problem. Determining the root causes of problems that occur in the process is carried out for each problem that occurs.
4. Arrange the priority root causes of the problem. One problem can have several causes for the problem. At this stage, the root cause is chosen which will be the target of improvement.
5. Reviewing the Analyze stage

➢ *Improve*

Improve is finding the right solution to overcome the problem.

The steps taken on Improve:

1. Looking for potential solutions Document all solutions, statistical analysis or other tools used to develop solutions, register all proposals given by process participants, process owners.
2. Select and prioritize solutions Prioritize solutions that have been listed from the previous stage, then choose a solution that must be implemented first according to the level of importance.

➢ *Control*

Control is to complete all activities to improve and convey the results of the improvement process and ensure that everyone working has been trained to carry out new repair procedures.

Stages in Control:
1. Hold monitoring of the results of implementation
2. Documenting new standard operating procedures
3. Make a process control plan
4. Create a travel map / project history
5. Carry out the process of transition and transfer of responsibility to the owner of the process
6. Reviewing the control phase

III. RESEARCH METHOD

In this study the type and design of research used is quantitative research. The research was carried out in Appliance Company in Jakarta Indonesia. The data and information in this study are collected and determined, including:

1. Flow of the production process for making products
2. Flow of door production process
3. The critical point that affects the product by describing the elements of the six sigma DMAIC approach
4. Defect data from the sales department's customer service section.

The technic analysis in this study is the Six Sigma DMAIC method which includes Define-Measure Analysis-Improve-Control.

➢ *Define*

Define is a step to define and select problems to be solved along with costs, benefits and impacts on customers (customers). What is done in this stage is data collection of variables related to the problem or damage by making a SIPOC diagram (Supplier, Input, Process, Output, Customer), which is made in detail and complete so that all components of the variable will be confirmed.

➢ *Measure*

Measure is a stage of measurement of defined problems to be solved. In this stage there is data retrieval which then measures the characteristics and capabilities of the process at this time to determine what steps should be taken to make further improvements and improvements. In the measure phase, the variables that are confirmed or carried out data collection and data analysis are as follows:
1. Measurement of the amount of injection of urethane material
2. Door shell panel material, inner door material and inner door hole
3. Temperature jig inside and outside
4. Head inject machine air pressure

➢ *Analysis*

Stages of analysis are stages to find solutions to solve problems based on root causes that have been identified. In this stage, we must be able to analyze and validate the root causes.

In this study, the analytical methods used Cause effect diagram or fish bone diagram is to describe the possible influence of causes of 4 main factors, namely Man (human), Material (material), Method (method), and Machine (machine / tools / jig).

➢ *Improve*

The improve stage is to take corrective actions to the problem by conducting tests and experiments to be able to optimize the solution so that it is really useful to solve the problem. This stage can be done if the stage after the previous stage, Define, Measure and Analyze is done.

➢ *Control*

The purpose of the control stage is to establish standardization and control and maintain the process that has been improved, evaluated to prevent potential problems that will occur in the future. In this study, the tools used are control charts and for see the effectiveness of improvement use of charts known as "two way charts". With this chart can be seen easily and clearly the effectiveness of the proposed improvements that have been made, whether the damage that occurred was the result of production before or after repairs. If data on damage after repairs is obtained is decreasing, it means the proposed improvements made are effective.

IV. RESULT

SIPOC Diagram is used to identify all the elements that make it possible in the repair process that are not well covered. The SIPOC diagram is similar to a process diagram, but provides complete details.

Supplier	Input	Process	Output	Customer
Urethane material	Polyol, Isocyanate, Cyclopentane	Material mixing & ratio	Panel Door Foam without defect	Customer Domestic & Export
	Chiller Temperature Material	Urethane charging amount & Density		
Panel Sheet	Panel door metal	Panel door shell: cutting, punching, bending & cap door assembly		
Inner Door	Inner door with hole standard	Inner door & panel door shell assy, Air Evaporating		
Urethane Jig (mold)	Urethane door Jig	Inside & Outside jig temperature		
Head Inject Machine	Charging mechanism	Form Pattern urethane charging		
	Air Pressure			
Human Resource Section	Operator, skill, knowledge Workforce	Assembly panel shell & Inspection		

Fig. 1:- SIPOC Diagram for Making Door Process

After the problem was defined the next step was to collect historical data to get the information about processes which were to be improved, check if there was enough data, documentation of the current situation and also perform the comparative tests.

In this measure phase, data collection is carried out on each process related to the damage that occurs and how to measure the data collected so that it can be known the possibility of deviation from the process.

In this study, there are 5 factors for measure confirmation. The factor material is Amount of urethane Inject and confirm by data at the control chart is no problem. The data can be shown as below:

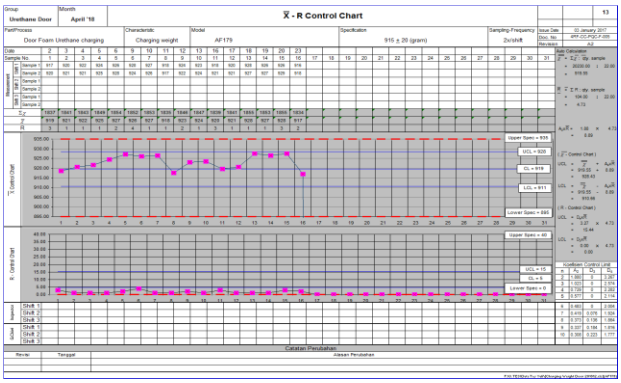

Fig. 2:- Control Chart Amount of Urethane

The door shell panel material has no material changes and the results of process cutting, punching and bending. Checking data is obtained from sampling checking data and found no abnormalities. For door inner and hole checking, the results of checking found on the top and bottom position of the hole is not in accordance with the standard, after confirmed the injection results found that there is material that is not full so that the potential for damage. The temperature of the urethane door jig on the inside and outside is measured by the IR thermometer. The temperature measurement results show the temperature of the jig according to the standard, namely for the inside jig of 42.6ºC (standard 40-60ºC). While for the outside jig is 41.8ºC (standard 40-55ºC). Head Inject air pressure is checked by looking at the needle indicating the pressure gauge in the inject head area. And the results of checking the air pressure obtained data pressure of 12 MPa. Of the 5 items confirmed, the inner door item with the position of the hole that occurs is a deviation. Then proceed with a more detailed and detailed analysis phase to find out the root causes of door damage.

Data that has been obtained in the previous stage, namely the measure stage, is then analyzed to find the root cause of the damage. At this stage of analysis is done using a cause effect diagram or fish bone diagram.

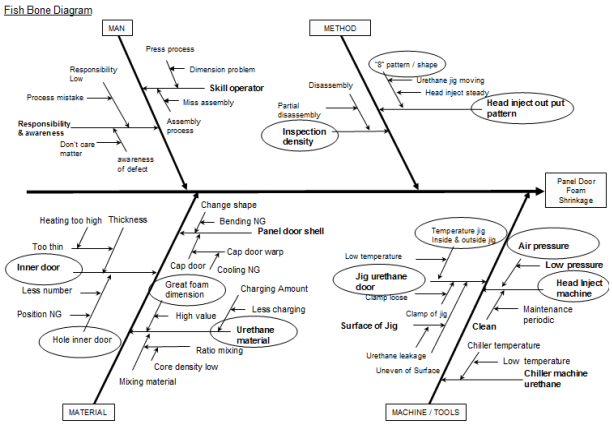

Fig. 3:- Fishbone Diagram Caused of the Damage

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After the analysis stage, continue to improvement stage is the proposed stage of improving the quality of production with the DMAIC method. The proposed improvement can be seen in table 1 below:

No	Problem	Analysis	Improvement	Date	PIC
1	Air vent hole: Qty Less Position Problem	Manual process boring diameter 0.5mm	1. Strength request to supplier to follow standard/spec 2. Marking limit sample boring hole 3. Strength control receiving inspection by IQC	06-Mar-18	Topla, Ilham, Yuli
2	Density not uniform at the 5 point	1. Urethane flow pattern "8" pattern 2. Charging head steady, jig moving	1. Change of mechanism urethane charging inject 2. Charging head moving, jig steady	12-Feb-18	Agung
3	Dimension stability +2% ~ - 2%	Material characteristic (material covestro)	1. Change to material DOW 2. Dimension stability <1% 3. Dimension stability related with shrinkage material More value	15-Jan-18	Fatah
4	Current inspection can't defect of problem early	There aren't disassembly of inner door to check urethane flow	Add disassembly of inner door when inspection charging amount & density check	01-Mar-18	Riwan, Yuli

Table 1:- Improvement Proposal

Control is the final stage of Six Sigma activities with the DMAIC method. From the analysis of measurements and improvements proposed, then repeated measurements were made. This is done so that the analysis and proposed improvements have been made whether they have a good level of effectiveness or not. Control devices are used which are known as Diagram two way charts. With this chart, it can be seen the effectiveness of the proposed improvements by looking at 2 (two) directions, namely in terms of when the problem occurred and when the product was produced. So that it can be seen whether the problematic product damage is the product produced before the proposed improvement or whether after the proposed improvement. The two way chart diagram can be seen in Figure 2 below:

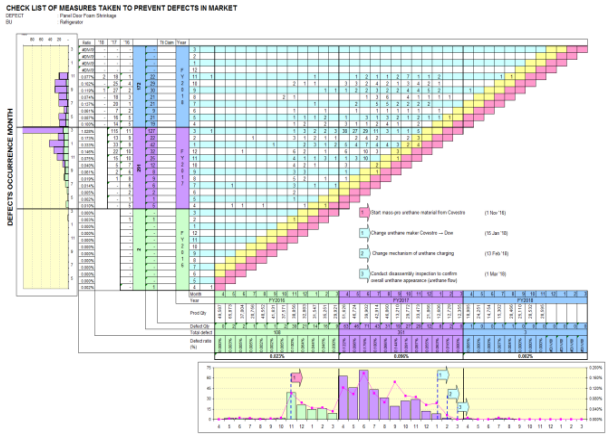

Table 2:- Two Way Chart Control

V. CONCLUSION

From the case studies conducted it can be concluded that six sigma with the DMAIC approach can be used to improve door defect that occurs in appliance companies. Activities start from identifying problems, measuring data from the factors that influence, analyzing the factors that influence it, followed by submitting improvement ideas and finally controlling the improvements that have been made.

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