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Application of Six Sigma (Dmaic) Method to Reduce Defect Amount in Assembly Process A Case Study PT. XYZ

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Abstract *– PT. XYZ is a company engaged in industry and manufacturing in the manufacture of sports shoe products. The company has a very high defect in the assembly process seen in the defective rate report from January 2017 to August 2018. The purpose of this study is to reduce the number of defects in the assembly process using the Six Sigma (DMAIC) method. The results showed that there were 5 dominant types of defects related to Critical To Quality (CTQ), namely Undercement, Dirty shoes, Unpairing-heel height, Broken stitching and Quarter wrinkles. Furthermore, an analysis of the causes of defects is carried out by using cause and effect diagrams and an improvement effort using 5W + H analysis. The results of efforts to decrease the number of defects in the assembly process using the DMAIC method show that the DPMO value for these five CTQ defects decreased to 2056 PPM from 3898 PPM or decreased by 47.3%. Whereas for the value of the sigma level obtained 4.39 σ from 4.16 σ.*

Keywords: *six sigma; DMAIC; quality; defect*

INTRODUCTION

Quality products are one of the factors that can influence competitive advantage in winning global market competition, in addition to price and distribution range. Therefore, every company always strives to develop its products, in order to be able to compete with competing products in the market. The most important element in the product is quality. The quality of products (goods or services) produced by a company is the main factor that determines the performance of the company.

PT. XYZ is one of the manufacturing companies that produce footwear products in Indonesia from 1985 to the present. One of the footwear products from PT. XYZ is a sport shoe with the Japan brand. Problems that arise in the assembly process have a number of product defects that exceed the maximum tolerance limit of defects that are equal to 2.88% in January 2017 to August 2018. From the calculation of actual defect per line assembly there is one line that has the highest number of defects namely assembly process cell 1. Where the results of the analysis of the achievement of defects that exceed the maximum tolerance limit, there are 5 highest defects, among others, Under / open bond, Dirty shoes, Unpairing-heel height, Broken stitching and Quarter wrinkles. By looking the number of defect products that exceed the maximum tolerance limit, Company needs to take quality improvement measures to reduce the level of shoe defects so that product quality increases. There are several methods in controlling and improving quality to reduce defect levels, one of which is using the Six Sigma (DMAIC) method. In this study, researchers used the method Six Sigma DMAIC approach to reduce the number of defects in assembly process.

The purpose of this study is to reduce the number of defects with the Six Sigma DMAIC method by Knowing the sigma level for the level of defects associated with shoe defects in assembly process, Identify the causes of high levels of shoe defects in assembly process and Determine effort for improvement and solutions to overcome the defect with Six Sigma DMAIC method in assembly process cell 1.

The limitation of the problem of this study is that the defect data studied focuses on the production process in the assembly cell 1 and kind of defects product that will be the focus of the research are defects that exceed the maximum tolerances limits, namely Under cement / Open bond, Dirty Shoes, Unpairing- heel height, Broken Stitching, and Quarter Wrinkle. And then an analytical method used in this study is the DMAIC method (Define, Measure, Analyze, Improve and Control).

And for data used after the application of DMAIC is defective product data in January-March 2019 in Assembly process cell 1.

LITERATURE REVIEW

Mursyidi (2008: 119) defines defective products which are products that do not comply with predetermined quality standards, which can be economically repairable. Supported by the opinion of Bastian and Nurlela (2010: 13), defective products are products that are produced in the production process, where the products produced are not in accordance with the specified quality standards, but economically these products can be repaired by issuing certain costs. As explained in Supriyono (2011: 121), a defective product is a product that is in a damaged condition or does not meet the specified quality measure, but the product can still be repaired economically as a good product. As stated by Firdaus & Wasilah (2012: 69) defines that defective goods / products are goods that do not meet production standards due to errors in materials, labor or machinery and must be processed further in order to meet specified quality standards so that the items can be sold.

Joseph Juran (1988) in Yuri, Nurcahyo (2013: 11) in the Quality Control Handbook defines quality as a fitness for purpose. This definition is based on the definition of quality itself, which can be interpreted as meeting requirements or conformity to needs. Regarding quality as conveyed by Armand V. Feigenbaum (1991) in Yuri, Nurcahyo (2013: 11) mentions quality in his book, Total Quality Control, as the total composite product and service characteristics of marketing, engineering, manufacturing, and maintenance through which the product and service will meet the expectations of the customer. Quality refers to the ability of a product or service to consistently meet or exceed customer expectations. Different customers will have different requirements so that the definition of quality can be interpreted depending on who our customers are. (Stevenson, 2014: 405). Quality control, the products produced have good quality in accordance with established standards. Good or very good business organizations usually benefit in various ways such as: improving reputation, the ability to determine premium prices, increasing market share, greater customer loyalty, lower production costs, fewer production problems, increasing productivity, fewer complaints from customers, and higher profits or profits (Stevenson, 2014: 416).

Six sigma is a business process to improve quality, reduce costs, and increase customer satisfaction. This refers to programs designed to reduce the occurrence of defects to achieve lower costs and increase customer satisfaction. Six Sigma programs can be used in design, production, service, inventory management, and shipping. (Stevenson, 2014: 426). As supported by Heizer (2017: 259), it defines that Six Sigma is a program designed to reduce defects to help reduce costs, save time, and increase customer satisfaction. in a statistical sense, six sigma describes a process, product, or service with very high capabilities with an accuracy of 99.9997%, or 3.4 defects per million. As stated by Greg Brue (2015: 1) Six Sigma is a methodology for using a series of techniques and tools to improve the quality of a product or service by identifying and reducing or eliminating the causes of defects or errors and minimizing variability in the process. Six sigma is a continuous improvement effort to reduce process variations in order to increase process capability in producing product with zero defects with a minimum target of 3.4 DPMO (Defect Per Million Opportunities), to provide customers value. Gasperz (2007: 6). Then supported by Tannady (2015: 25) Six Sigma is a phenomenal quality improvement method and is widely used by companies and organizations, by putting forward the concept of one million products there will only be 3.4 defects of manufactured product.

Six Sigma methodology uses statistical tools to identify several important factors, the most important factors to improve the quality of the process and produce bottom line results. These tools are presented and discussed during the phase in the six sigma process they first used. The form is DMAIC which consists of five phases namely Define, Measure, Analyze, Improve & Control. (Greg Brue, 2015: 8). According to Tannady (2015: 26), the concept of DMAIC (Define-Measure-Analyze-Improve-Control) is a method used to measure the application of Six Sigma in an organization. As Lindsay (2015: 47) stated in the main problems solving methodology used in Six Sigma is DMAIC, which is a structureds problems solving process to solve problems starting with Define, Measure, Analyze, Improve and Control stages. And supported by Heizer's opinion (2017: 259) to make it

happen, six sigma requires the DMAIC process stage. DMAIC starts with the Define, Measure, Analyze, Improve and Control processes.

Define

Define stage is the initial identification stage, where at this stage, the organization must be accurate and observant in seeing the impact of the problems that arise. This stage generally starts with creating a Project Charter and observing the production flow that is currently being used through the SIPOC (Supplier-Input-Output-Customer) diagram.

Measure

The measurement of the quality of the final product from the existing process is a parameter of how to assess the capability of the current process. The measure stage is also followed by determining the description of CTQ (Critical To Quality), and the sigma level of the current process. Critical To Quality (CTQ) is used to identify the specific needs of consumers. CTQ can be interpreted as attributes of a process that is very important and has a direct effect on achieving the desired quality of consumers (Gaspersz, 2002). CTQ is a way of measuring product / process standards that must be in accordance with customer satisfaction. The level of customer satisfaction can be an added value to get CTQ. CTQ can be determined through research or experiment. From the results of the study, then what characteristics are chosen in the process that causes the occurrence of defects so that the observed product is declared a failure.

Sigma levels are measured based on some initial inputs and parameters, such as the number of product defects, the number of production units, the number of defects, the number of defects in each production (Defect per Units / DPU), the number of defects in each a number of opportunities (Defect per Opportunities / DPO), and the number of defects in every 1 million production (Defect per Million Opportunities / DPMO). The smaller the value of DPMO, the greater the Sigma value.

Analyze

Analyze phase in DMAIC serves to provide input on priorities in efforts to overcome the cause of the problem, show the impact of the failure of the process and the final product on the consumer, describe the causes of failure to the root causes of the problem and provide input for improvisation efforts. Some tools that are commonly used in the Analyze stage are Cause Effect Diagram, Pareto Diagram, Brainstorming.

Improve

At this stage, the process carried out is to make various efforts to eliminate various causes of product defects or process failures. In this process all efforts or proposed improvements are applied to the process, therefore to achieve improved results the potential solutions that have been produced must be applied appropriately.

Control

The control phase has the function of supervision and monitoring of planned and scheduled improvement plans. Making Error Proofing to prevent defects and existing improvement efforts are controlled or achieved technically and all efforts are documented and socialized.

METHODS

The type of research used in this research is descriptive explorative. Descriptive research is analyzing and presenting data systematically, so that it can be more easily understood and concluded while exploratory research itself has the purpose of exploring extensively about the causes or things that affect the occurrence of something (Suharsimi Arikunto. 2013: 7). So descriptive exploratory method is research with problem solving that is explored extensively about the causes or things that affect the occurrence of something by collecting data relating to the problem under study, then processed and analyzed so as to provide a real picture on objectively studied object and provide solutions to a problem.

Operational definition is the elaboration of concepts or research variables in measurable details that are needed to avoid interpreting errors of the variables analyzed or to limit the problems in this

study, so it is necessary to explain the definition of operational variables based on secondary data indicators as shown in Table 1.

Table 1. Operasional Definition

Variable	Dimension	Indicators	Data Type
Quality Control	1 Variable Failure	a. Total Production	Secondary
	2 Attributes Failure	a. Number of Undercement/ Open bond defects	Secondary
		b. Number of Dirty Shoes defects	Secondary
		c. Number of Un pairing-Heel high defects	Secondary
		d. Number of Broken stitching defects	Secondary
		e. Number of Quarter wrinkle defects	Secondary
	3 Action against the cause of attribute failure	a. Causes of Machine Factors	Primary
		b. Causes of Human Factors	Primary
		c. Causes of Method Factors	Primary
		d. Causes of Material Factors	Primary

Source: Josep Juran (1988) dalam Nurchayo (2013)

The study population was shoe products in cell 1 in the assembly process at PT.XYZ which was produced in January-March 2019 was 56,738 pairs. Product sampling used by researchers is a product sample according to the characteristics of the type of shoe product defect from the production of assembly cell 1 and the cause also originates from the Assembly cell 1 process in January to March 2019.

The flow chart of Framework can be seen in Figure 1. In this flow diagram explained about the stages of research carried out, the research method is in accordance with the stages of implementation of Six Sigma DMAIC (Define-Measure-Analyze-Improve-Control).

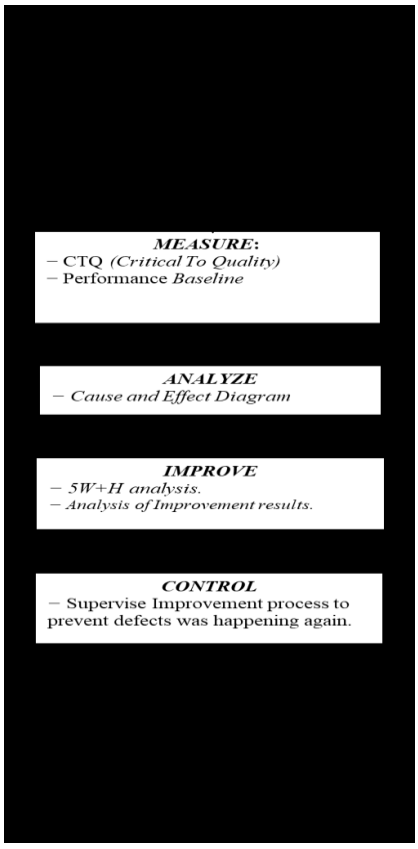

Figure 1. Flow chart of Framework

RESULTS and DISCUSSION

This study uses the Six Sigma DMAIC approach (Define, Measure, Analyze, Improve and Control) which is a comprehensive approach to solving problems and improving the six sigma process. The implementation of Six Sigma is done after determining the goals and criteria of the Six Sigma project.

Define

This Define stage is the first stage in the process of improving quality on the Six Sigma method. At this stage, a process of defining a number of things related to the problems that will be discussed includes defining the Supplier Input Process Output (SIPOC) and problem identification by recording and collecting the types and types of defects that occur. The final result of the assembly process greatly determines the quality of the shoes. The SIPOC diagram of the Assembly process can be seen in Table 2.

Table 2. SIPOC Diagram *Assembly Process* Cell 1

Supplier	Input	Process	Output	Customer
-Stockfitting dept	-Outsole	Lasting Upper	-Lasted Upper	-Final Quality Control.
-Sewing Dept.	-Upper	Drawing Marking upper to Outsole	-Finish shoe	
-Planner Dept.	-Schedule			
-Dev dept.	-Procedure	Buffing upper on marking line		
		Cleaning Upper & Outsole		
		Primering Upper & Outsole		
		Cementing Upper & Outsole		
		Attaching Upper to Outsole		
		Shoe Pressing		
		Open shoe lasted		

Source: PT. XYZ (2019)

Output is the product of a process. The output of the assembly process is defective free shoes. The shoes produced must be able to satisfy the customer or can meet CTQ (Critical to Quality) from the customer. Output is the product of a process. The output of the assembly process is defective free shoes. The shoes produced must be able to satisfy the customer or can meet CTQ (Critical to Quality) from the customer.

Measure

The measure stage is the second stage of the improvement process with the Six Sigma method in improving quality. At this stage it can help understand the conditions or performance of a current process before identifying the process of quality improvement that will be carried out. The sequence to be carried out in the measure stage is by determining the quality characteristics of CTQ (Critical to Quality), calculating the DPO and DPMO and the sigma level to measure current performance (baseline), then mapping the assembly process performance through the Control Chart.

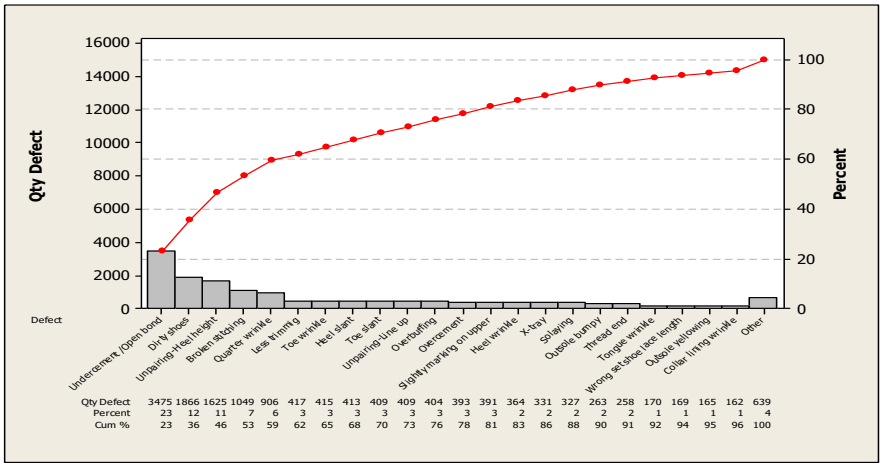

Figure 2. Pareto Diagram *defect Assembly Process*
Source: *Department Quality Control* PT.XYZ (2018)

By using the 80/20 criteria pareto diagram, 20% of the types of disability can cause 80% of process failures. Then taken 80% of the biggest reject criteria to be analyzed to solve the problem as shown in Figure 3. So that will be the focus of this research is assembly cell 1 with five types of defects that exceed the maximum permissible tolerances as in table 3.

Table 3. Achievement per 80% Defect Category

No	*Defect*	*Defect (%)*	*Maximum tolerance limit defect (%)*	*Gap*	*Judgment*
1	*Undercement /Open bond*	23.14	2.85	20.29	NG
2	*Dirty shoes*	12.42	2.85	9.57	NG
3	*Unpairing-Heel height*	10.82	2.85	7.97	NG
4	*Broken stitching*	6.98	2.85	4.13	NG
5	*Quarter wrinkle*	6.03	2.85	3.18	NG
6	*Less trimmig*	2.78	2.85	-0.07	OK
7	*Toe wrinkle*	2.76	2.85	-0.09	OK
8	*Heel slant*	2.75	2.85	-0.10	OK
9	*Unpairing-Line up*	2.72	2.85	-0.13	OK
10	*Toe slant*	2.72	2.85	-0.13	OK
11	*Overbuffing*	2.69	2.85	-0.16	OK
12	*Overcement*	2.62	2.85	-0.23	OK

Source: *Department Quality Control* PT.XYZ (2018)

After identifying the characteristics and types of defects that occur in the Assembly process, then at the measure stage, Critical to Quality (CTQ) is determined or the characteristics of defects that are considered the most critical in the Assembly process are as follows:

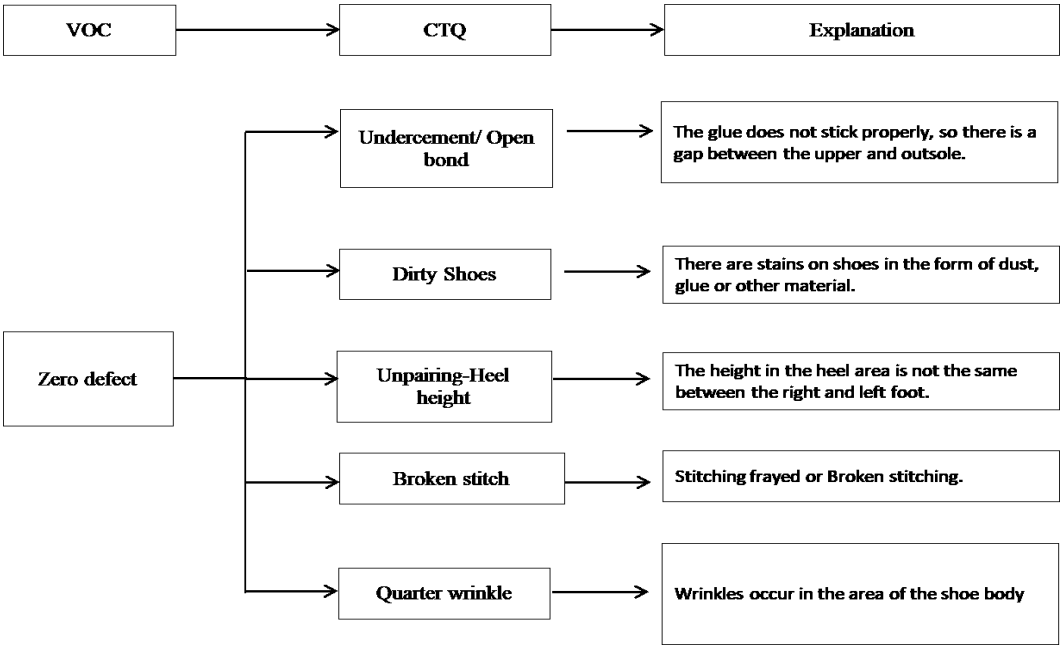

Figure 3. Critical To Quality Tree
Source: *Department Quality Control* PT.XYZ (2018)

Table 4 measures the assembly line capability of Cell 1 in producing a product. The average sigma value for 5 CTQ defects is 4.2. Furthermore, the results of the measurement of the performance base line will later be used as targets or comparative data before and after repairs.

Table 4. Level Sigma Total 5 Defect Critical to Quality January 2017-August 2018

No	Defect	Total Production	Qty Defect	CTQ	DPO	DPMO	*Level sigma*
1	5 CTQ	457770	8921	5	0.003897590	3897.59	4.16
2	*Undercement /Open bond*	457770	3475	1	0.007591148	7591.15	3.93
3	*Dirty shoes*	457770	1866	1	0.004076283	4076.28	4.15
4	*Unpairing-Heel height*	457770	1625	1	0.003549818	3549.82	4.19
5	*Broken stitching*	457770	1049	1	0.002291544	2291.54	4.33
6	*Quarter wrinkle*	457770	906	1	0.001979160	1979.16	4.38
Average							4.19

Source: *Department Quality Control* PT.XYZ (2018)

Analyze

In analyzing data from the measure stage is used to find a causal relationship in the process. Analysis with Cause and Effect Diagram is an effective method to find the root cause of the problem because this method analyzes the causes of problems with 4M analysis, namely Man, Machine, Material, and Method. The principle of a causal diagram is to trace all the possibilities that occur as a cause of a problem.

Analysis Cause and Effect diagram defect Undercement/ Open bond

Defect Under cement or open bond is a type of defect caused by glue or cement that does not bonded well into the upper material, For the cause and effect diagram defect undercement / open bond is as follow:

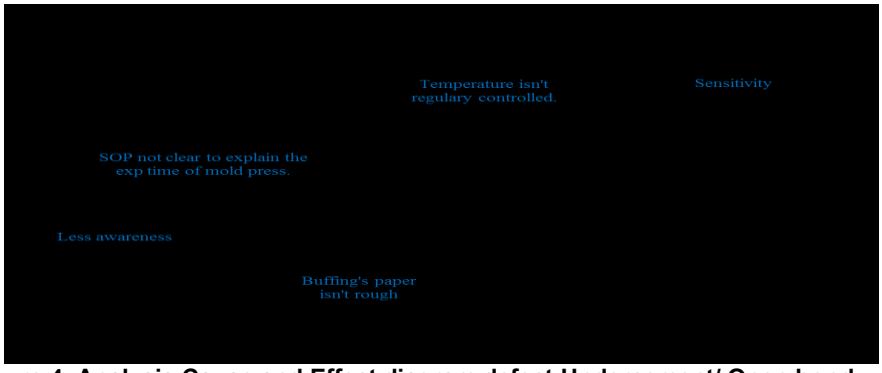

Figure 4. Analysis Cause and Effect diagram defect Undercement/ Open bond
Source: Result of discussion with Dept. Quality Control and Production (2019)

Analysis Cause and Effect diagram defect Dirty shoes

Defect Dirty shoes are a type of defect with conditions on the upper shoe stain. which is due to the different stages of the shoe cleaning process and the attitude of workers who do not follow the existing SOP. For defect Dirty shoes, cause and effect diagram analysis are as follows:

Figure 5. Analysis Cause and Effect diagram defect Dirty shoes
Source: Result of discussion with Dept. Quality Control and Production (2019)

Analysis Cause and Effect diagram defect Unpairing-Heel height

Defect Unpairing-heel height is a type of defect where there is a high inequality of the back between the right and left foot shoes. For cause and effect diagram, defect Unpairing-heel height is as follows:

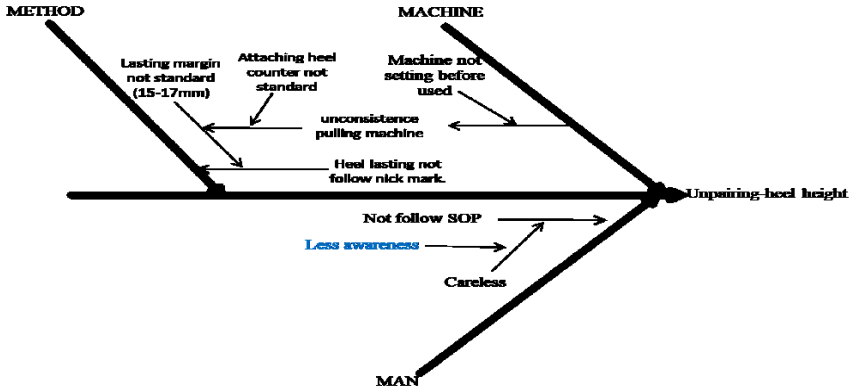

Figure 6. Analysis Cause and Effect diagram defect Unpairing-Heel height
Source: Result of discussion with Dept. Quality Control and Production (2019)

Analysis Cause and Effect diagram defect Broken stitching

Defect Broken stitching is a type of defect where the upper stitch is cut off, which is caused by a sewing process that is too tight so that there is no room for thread when the lasting process. For Broken Stitching defect analysis and cause and effect diagram are as follows:

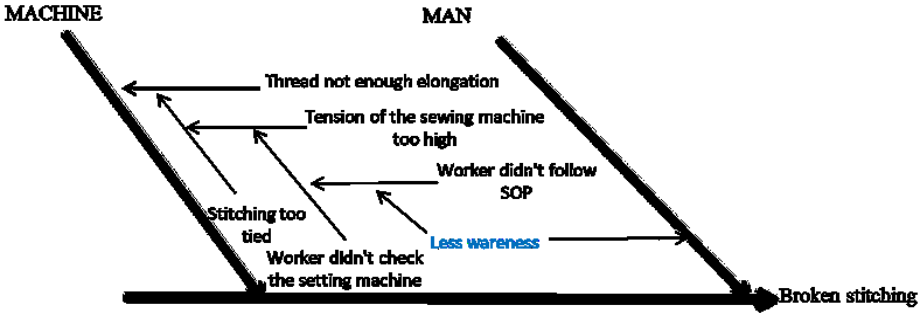

Figure 7. Analysis Cause and Effect diagram defect Broken stitching
Source: Result of discussion with Dept. Quality Control and Production (2019)

Analysis Cause and Effect diagram defect Quarter wrinkle

Defect Quarter wrinkle is a type of defect where the shape of the shoe body is not fitting with shoe laste, for cause and effect diagram defect quarter wrinkle analysis are as follows:

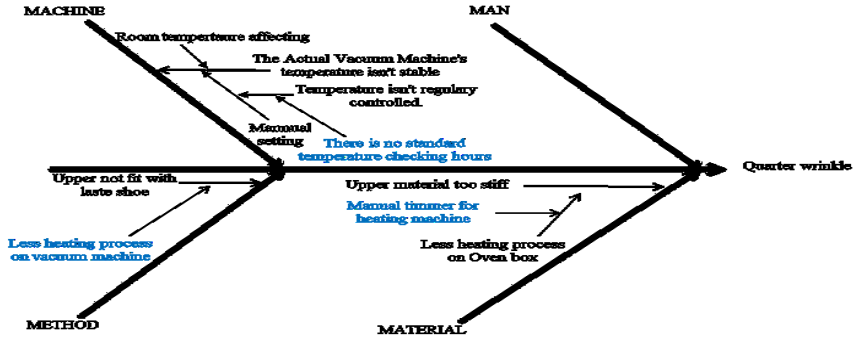

Figure 8. Analysis Cause and Effect diagram defect Quarter wrinkle
Source: Result of discussion withDept. Quality Control and Production (2019)

Improve

Improve is a phase to improve the process and eliminate the causes of failure. The main activity at this stage is finding ideas for improvement on the main factors that have been determined in the analyze stage. This stage will help improve quality by reducing the level of defect in the assembly process. The method used for this proposal is the 5W + 1H method. This method is used to determine what actions should be taken for each cause of defect.

Table 5. Improvement for Defect Undercementing / Open bond

Factor	Problem	Root Cause	What	Why	Who	Where	When	How
Method	Pressure machine is not consistance	SOP is not clear to explain the exp time of mold press	Add the expired time of mold press	To make consistence of the pressure machine.	Supervisor, Engineering. & Quality Control.	Production	19-Jan	Revised the SOP by adding the mold usage expiry date.
	The actual machine's temperature isn't stable.	There is no written SOP to check the machine temperature regularly per hours.	Make SOP and PIC to check machine temperature	To keep machine temperature was stable during mass production.	Supervisor,Engineering& Quality Control.	Production	19-Jan	Make SOP checking machine temperature and line chart's actual temperature per hours.
	The Cement not absord well on to the upper material.	Not good condition of the buffing's paper.	Control the condition of buffing's paper	To make cement easily penetrate and merges with upper material.	Supervisor,Engineering& Quality Control.	Production	19-Jan	Make hourly buffing's paper change schedule.
Man	Less awareness	No sense of responsibility to their work.	Training and briefing the worker	Improve quality of worker.	Supervisor, HR & Operator.	Production	19-Jan	Do training and briefing the worker regarding SOP and daily basic process.

Source: Result of discussion with Dept. Quality Control and Production (2019)

Table 6. Improvement for Defect Dirty shoes

Factor	Problem	Root Cause	What	Why	Who	Where	When	How
Man	Cleanless of Conveyor machine	Less awareness	Educate and coach the worker	Improve quality of worker.	Supervisor, HR & Operator.	Production	19-Jan	Do training and briefing the worker regarding SOP and daily basic process.
Method	Different way of shoe cleaning process	SOP didn't mention the details stages of cleaning shoes.	Standardize how to clean the shoe.	Eliminate variation of cleaning process	Supervisor, Operator and Engineering	Production	19-Jan	-Revised SOP by adding the stage cleaning process. - Standardize the tools to cleaning shoe.

Source: Result of discussion with Dept. Quality Control and Production (2019)

Table 7. Improvement for Defect Unpairing heel height

Factor	Problem	Root Cause	What	Why	Who	Where	When	How
Man	Heel lasting not follow the nick mark	Less awareness	Educate and Coach the worker	Improve quality of worker.	Supervisor, HR & Operator.	Production	19-Jan	- Do training and briefing the worker regarding SOP and daily basic process. - Supervisor have to do random check the result of lasting process twice a day.

Source: Result of discussion with Dept. Quality Control and Production (2019)

Table 8. Improvement for Defect Broken stitching

Factor	Problem	Root Cause	What	Why	Who	Where	When	How
Man	Thread not enough elongation	Less awareness	Educate and coach the worker	Improve quality of worker.	Supervisor, HR & Operator.	Production	19-Jan	- Do training and briefing the worker regarding SOP and daily basic process. - Supervisor have to do random check the result of lasting process twice a day.

Source: Result of discussion with Dept. Quality Control and Production (2019)

Table 9. Improvement for Defect Quarter wrinkle

Factor	Problem	Root Cause	What	Why	Who	Where	When	How
Machine	Upper material is stiff	Manual timer for heating oven box machine.	Change the timer from manual to automatic.	Improve accuracy timer of heating process.	Supervisor & Engineering	Production	19-Jan	Modified the oven box machine use automatic timer.
Method	The actual Vacuum machine's temperature isn't stable.	There is no written SOP to check the machine temperature regularly per hours.	Make SOP and PIC to check machine temperature	Keep Vacuum machine's temperature was stable during mass production.	Supervisor, Engineering & Quality Control.	Production	19-Jan	Make SOP checking machine temperature and line chart's actual temperature per hours.

Source: Result of discussion with Dept. Quality Control and Production (2019)

Improvement Result

After the above corrective actions are taken, there is a decrease in product defect. At this stage, a process monitoring is carried out to assess whether the improvements made can reduce the DPMO value and increase the sigma value. Data analysis after repairs for three months from January 2019 to March 2019 shows the following results:

Table 10. Improvement result of DPMO (PPM)

No	Defect	Target (Before Treatment)	1st Cycle Treatment January 2019 (PPM)	2nd Cycle Treatment February 2019 (PPM)	3rd Cycle Treatment March 2019 (PPM)	Average
1	5CTQ	3898	2638	2437	1094	2056
2	*Undercement /Open bond*	7591	4214	4437	2233	3628
3	*Dirty shoes*	4076	4130	3974	1954	3353
4	*Unpairing-Heel height*	3550	1896	1656	558	1370
5	*Broken stitching*	2292	1433	1325	447	1068
6	*Quarter wrinkle*	1979	1517	795	279	864

Source: Data processing (2019)

Table 10. shows the achievement of DPMO after repairs. From January to March 2019, on average, all 5 defects of CTQ decreased DPMO by 47.2% or 2056 PPM from the DPMO before threatment was 3898 PPM.

Table 11. Improvement result of Sigma Level

No	Defect	Target (Before Treatment)	1st Cycle Treatment January 2019 (σ)	2nd Cycle Treatment February2019 (σ)	3rd Cycle Treatment March 2019 (σ)	Average
1	5CTQ	4.16	4.29	4.32	4.56	4.39
2	*Undercement /Open bond*	3.93	4.13	4.12	4.34	4.20
3	*Dirty shoes*	4.15	4.14	4.15	4.39	4.23
4	*Unpairing-Heel height*	4.19	4.39	4.44	4.76	4.53
5	*Broken stitching*	4.33	4.48	4.51	4.82	4.60
6	*Quarter wrinkle*	4.38	4.46	4.66	4.95	4.69

Source: Data processing (2019)

Table 11. shows the achievement of sigma level after improvement. From January to March 2019 the overall overall 5 CTQ defects has increased sigma level with a mean of sigma value is 4.39 σ, which is increase by 5.5%.

Control

After the company designs or implements the repair process in the improve phase, the next step of the Six Sigma project is to control the improvements that have been carried out or planned. The way that can be done is to record all activities completely, then an assessment can be made of the improvements that have been achieved. The process of monitoring the repairs will be easily assessed if each process carried out has standardized procedures and tools to detect potential defects early so that the results will according to what is expected and able to reduce the value of DPMO and increase the level of sigma defect. In this regard, control is needed to handle defect / open bond defects, Dirty shoes, Unpairing-heel height, Broken stitching, and Quarter wrinkles. Control for repairs that have been done is to make mistake proofing, form making, work instructions and SOP. In addition, quality control and internal audit activities are carried out. This aims to see the condition of the assembly process, so that it can monitor the incompatibility that occurs. Quality patrol activities are carried out every week and are reviewed after the beginning of the month. Internal audit is conducted at least one year twice. This aims to see where the effectiveness of production activities has been carried out. The results of this internal audit will be used as material for management evaluation.

The results of this research with the Six Sigma DMAIC method in an effort to reduce the number of defects in the assembly process at PT. XYZ as follows:

The sigma level value for the level of defects associated with shoe defects in the assembly cell 1 process is Critical To Quality which is equal to 4.16 σ. While the sigma level for each CTQ defect is

Undercement of 3.93 σ, Dirty shoes of 4.15, Unpairing heel height of 4.19, Broken stitching of 4.33σ and Quarter wrinkle of 4.38 σ

The causes of defects included in Critcal To Quality are from human, machine, method and material factors. Various efforts were made to improve so as to reduce the number of defects that occur in the assembly process. Efforts to improve the defect are carried out by doing corrective actions such as conducting training, SOP revision, engine modification, and engine quality improvement. The cause of the high number of defects in the assembly process for 5 Critical To Quality defects is caused by factors Man, Method and Machine. Where human factors are caused by the attitude of operators who are less concerned during the production process where the operator does not run the SOP resulting in inappropriate products or defects. The attitude of workers who are less careful is caused by lack of caring for the operator, which the operator feels is not burdened on the product incompatibility that occurs. In the mind of the operator, the most important thing is to complete the work at the specified time. The improvement efforts are carried out by conducting training and briefing operators before carrying out work to increase knowledge of basic SOPs at each stage of the assembly process. Besides the factors that cause defect undercement that is caused by methods, SOPs that lack details make the gap for operators not to follow the SOP. So that improvements are made by reviewing the SOP and revising the SOP so that it becomes clearer and easier to understand by the operator. In addition to revising the SOP, supervisors also check the work results of the operators, so that there are inappropriate work deviations. early. The next cause is the engine factor, the condition of the machine has a great influence on the assembly process, namely the temperature of the engine that must be controlled during the production process. In addition to engine temperature, the cleanliness of the engine must also be considered because it will have an impact on the cleanliness of the products produced. Then the engine modification in the oven box becomes automatic timer, so the operator does not need to manually count during the hitting upper process.

CONCLUSION

From the results of improvements in January to March 2019, Application of Six Sigma (DMAIC) method were able to reduce the number of defects associated with 5 Critical To Quality defects. It can be seen from the increase in sigma value on average for 3 months treatments become 4.39 σ from the sigma level before improvement is 4.16 σ, In another word an increase in sigma level every month by 0.13. So that if an improvement or treatment is carried out continuously it will be able to produce a product with zero defect which will make a big profit for the company.

There are a number of limitations in this study, this study only focuses on reducing the number of defects in assembly processes, therefore If futher research is to be carried out, it is recommended to conduct further research on the impact of improvements to production costs, especially on reworks and the cost of repairs (repair), how much cost efficiency is obtained by the implementation of this Six Sigma DMAIC.

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