Analysis of Product Quality Improvement through Kaizen and DMAIC Method in Rubber Sole Manufacturing

Meike Elsye Beatrix

Faculty of Engineering

Industrial Engineering Program

Universitas Mercu Buana, Jakarta, 11650,

Indonesia

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ABSTRACT

The development of the non-oil and gas industry in the current era of globalization is growing. Therefore, every company should be able to compete strictly with other companies that produce the same products. To be able to survive in business competition, maintaining quality product and reducing waste is an absolute thing that should be done by the company. Apart from maintaining product quality, companies could be also make savings in the production process, one of which is by applying the Kaizen Method so that the resulting product does not have a high reject rate so that waste on the use of raw materials can be limited according to company standards. The company has a quality control system but has not implemented yet DMAIC method. PT. X is a labor intensive industry which is engaged in the business of produce rubber sole. This research used the Kaizen and (Define, Measure, Analyze, Improvement and Control) DMAIC method. This study aims to reduce the percentage of C grade rubber sole maximum to 3% as the company standards. The approach used in saving the use of raw materials is to use the Define, Measure, Analyze, Improvement and Control (DMAIC) method. Analysis of the results obtained by applying the method of DMAIC is the improvement of the quality of rubber sole. The results of this study are the percentage of C grade rubber before improvement is 5.5%, DPMO value is 10.395 and t Sigma is 3.80 and after improvement are the percentage of C grade rubber outsole is decreased to 2.9%, DPMO value is 7.278.81 with t Sigma value is 3.95.

Key Words*: Quality Control, DMAIC, Rubber sole, DPMO, Sigma level.*

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1. INTRODUCTION

PT X is a manufacturing company engaged in the production of sports shoes on an export scale. One of the company efforts to increase its income is by increasing the quality of the rubber outsole so that the efficient use of raw materials can be achieved. To solve this problem, researchers will use one method, namely Kaizen and DMAIC (Define, Measure, Action, Improve, Control). To provide satisfaction to consumers, especially in terms of quality, we need a method that can identify the causes related to the decline in product quality. Using the Kaizen and DMAIC methods are expected to minimize the number of defective products by continuously improving quality. Six Sigma is a comprehensive and flexible system to achieve, maintain, and maximize business success [5].

By using the six sigma method with the DMAIC approach, the company is expected to minimize the number of defective products by continuously improving quality because this method has the stages of Define, Measure, Analyze, Improve and Control (DMAIC). Define is a stage of determining potential defects and measure is a stage for measuring the company's performance before improvement. Analyze is a stage in analyzing the causes of the defect and the improvement efforts that can be made. Improve is the stage of the process of implementing improvement proposals and measuring performance. Control is a control stage so that improvement efforts can be carried out according to planning. In the process of meeting production targets, defective products are the biggest obstacle in the production process which can cause the targets not to be achieved and cause considerable losses.

An improved quality of vision towards the target of 3.4 failures per million opportunities (DPMO) for each user of the product (goods or services). Enterprising attempts toward perfection or failure to zero (zero defects) [5]. The value of 1.5 Sigma

shift is obtained from the research results of Motorolla over the process and industrial system, which according to research results that are as good of an industrial process will not be 100% was at one point the value of the target, however there will be a shift amounting to an average of 1.5 Sigma that value.

2. METHODOLOGY

Method of Six sigma approach needed to do continuous improvement i.e. a systematic approach based on Science and fact with the use of equipment, training and measurement, so all the customer's needs can be are met.

Six sigma is one of quality improvement system and the target is 4.3 failure per a million of the occasion for every transaction (goods/services), and it is activity towards perfection [5]. This resulted in the emergence of a sense of understanding of six sigma quality level that other quality level where is only 3.4 defects resulting from a million chance occurrence of defects (Defects Per Million Opportunity (DPMO), which has been proven by applying this method on improving the quality of the sandals in CV Sancu Creative Indonesia [14].

The method is used in the research is descriptive research to describe or analyzing a researcher results. However has not used for making broader conclusions [16]. This method is used to find out how the quality control has been carried out by PT. X and to find out how the impact DMAIC method when applied to the product rubber sole. The necessary data are obtained from the primary data through observation and interviews directly against the owner of the company as well as quality control manager, and secondary data in the form of data originating from the company, which is required in this research. The steps of the research are follows:

1. Define

The first stage in the process of Six Sigma is to define where in this stage is done identification and determination of CTQ defective product that is produced and the production process failure happened. To that end, do the collection amount of production, number of product defects of the product and identification of CTQ that contains these kinds of defects that occur in PT. X.

2. Measure

The second stage, namely measure done calculations DPMO, sigma level in order to be known on the PT. X. This step is done so that the company's performance in production can be known. The following formula is used: Defects per Unit (DPU) Defects per Opportunities (DPO) Defects per Million Opportunities (DPMO) DPMO = DPO X 1,000,000 in addition to calculating the DPMO and sigma value, also done the calculation against the costs incurred due to the defective product .

3. Analyze

The third stage is to analyze the search phase which the root cause of the problem that caused the defective product. Fishbone diagram applied to all types of potential CTQ means that cause of the most defects. The data obtained through interviews with a production and quality manager.

4. Improve

The fourth stage is the stage of problem solving disability rubber sole. Some problems has been identified and already define the possibility root cause. At this stage is using tool 5W+1H for providing some suggestions for making an improvement plan [12].

5. Control

The fifth stage or final stage is control. The evaluation for all corrective actions which have been done and should have to know the success of the efforts are applied and also for the new problems arise could be prevent immediately.

3. RESULTS AND DISCUSSION

3.1 Problem statement

Department of Quality Control has set several quality standard specifications for rubber sole to meet customer satisfaction. However, from the predetermined standard specifications there are still production results of rubber sole having defects such as contamination, color bleeding, lack of material, bubble and dent.

To reduce defective products that occur of C grade rubber sole due to defective products and ensure customer satisfaction with the products produced while maintaining quality

3.2 Measurement Stage

Below is the C Grade Rubber Sole data for June 2020 - Oct 2020. As can be seen in table 1 the percentage of C Grade Rubber Sole is an average of 5.2%. Meanwhile, the standard tolerance of the company is 3.0%. For this reason, researchers will conduct research to be able to reduce the percentage of C Grade rubber sole using the DMAIC method.

Table 1. Data C Grade Rubber Sole
(June 2020 – Oct 2020)

Month	Total Prod A Grade (prs)	Weight per pair(kg)	A Grade (kg)	C Grade (kg)	%
June	912,717	0.31	282,942	16,677	5.6
July	1,063,877	0.36	382,996	20,286	5.0
Aug	906,497	0.34	308,209	17,339	5.3
Sept	1,246,992	0.35	436,447	21,365	4.7
Oct	1,041,391	0.34	354,073	26,380	6.9
Avg	1,034,295	0.34	352,933	20,409	5.2

At the measurement stage, critical to quality (CTQ) potential is determined as a characteristic that affects quality and is directly related to customer satisfaction and measures DPMO (Define Per Million Opportunities) which is then converted into sigma level.

a. Determine Critical To Quality (CTQ) rubber sole

PT. X has Critical To Quality (CTQ), namely Contamination, Color bleeding, Lack of material, Bubble and Dent. The DPMO and Sigma level from June-Oct 2020 is listed in Table 2.

Table 2 Six Sigma and DPMO Levels
(June 2020 – Oct 2020)

Month	Total Prod (prs)	Total Defect (prs)	% Defect	CTQ	DPMO	Sigma
June	1,022,674	53,798	5.26	5	10,521	2.75
July	1,177,859	56,351	4.78	5	9,568	3.80
Aug	1,012063	50,997	5.04	5	10,078	3.80
Sept	1,373,583	61,042	4.44	5	8,888	3.85
Oct	1,181,681	77,588	6.57	5	13,132	3.70
Avg	1,153,572	59,955	5.20	5	10,395	3.80

Based on data as above the capability level of Six Sigma is 3.80 and DPMO is 10.395. The researcher want to make improvement by using DMAIC method.

The following are defect types of rubber sole for doing analyze the corrective actions as seen on table 3.

From the data on table 3, a Pareto diagram is made to determine the type of defect rubber sole on the largest percentage..

Table 3 CTQ Sequence
(June 2020 – Oct 2020)

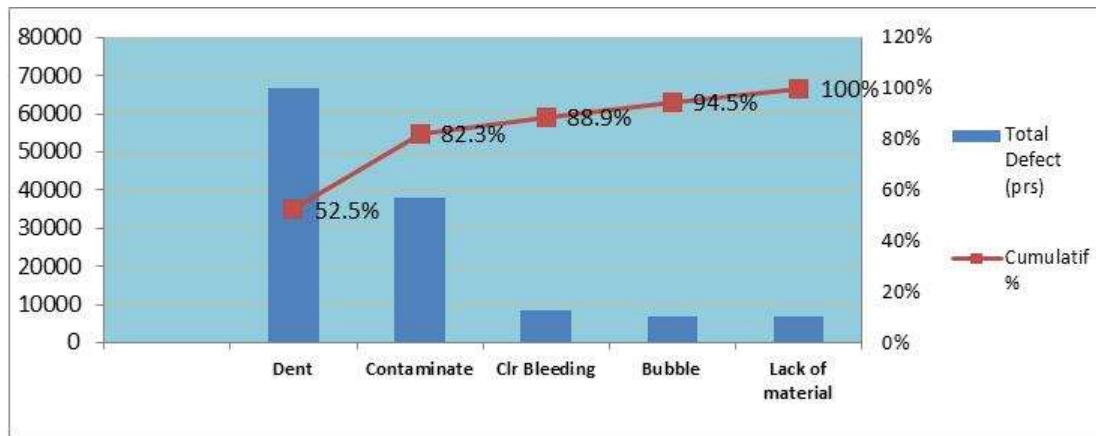| No.	Defect type	Total Defect (prs)	Total Defect Cumulative	%	% Cumulative
1.	Dent	66,744	66,744	52.45	52.45
2.	Contamination	37,928	104,672	29.80	82.25
3.	Color Bleeding	8,456	113,128	6.64	88.90
4.	Bubble	7,087	120,215	5.57	94.47
5.	Lack of material	7,042	127,257	5.53	100.00
	Total	127,257		100	

Figure 1. Diagram Pareto Rubber Sole
June 2020 – Oct 2020

The results of diagram Pareto in Fig. 1 shows the higher percentage of defect type is Dent (52.5%), Contaminate (29.80%), Color
Bleeding (6.64%), Bubble (5.57%) and Lack of material (5.53%). The analysis will then be carried out using a fishbone diagram to find out the root cause of the Dent.
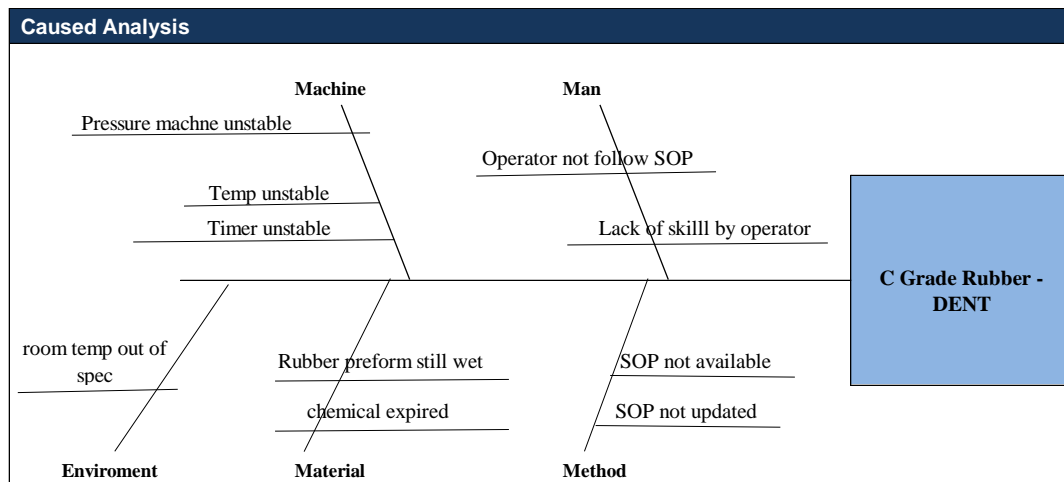

Figure 2. Fishbone Diagram

Fishbone diagram above is part of the seven tools that are used to analyze the causes of the main problems that occur at PT.X In this study it was found that defect type Dent that occurs in the Hot press production process. From the base of this problem will be analyzed the causes of the occurrence of this problem so that the main root problems are obtained which are then considered whether the corrective steps for this matter.
The following is a table of improvement planned of Dent at Hot press and Roll area.

Improvement Stage
The following is a table of improvement planned of C Grade Rubber sole as we could see on table 4.

Table 4. Improvement Plan uses 5W + 1H

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No.	Possible causes	What	Why	Where	When	Who	How
1.	Machine	Temperature, Timer and Pressure unstable	Check the condition of the machine before use	To reduce C grade rubber outsole	Prod Floor	Nov 2020	QA Team	Check machine condition every 2 hours
2.	Men	Operators are less precise and not follow SOPs	Conduct re fresh training on operators	To reduce C grade rubber outsole	Prod Floor	Nov 2020	Supervisor	Training and monitoring operator
3.	Method	SOP not updated	Update SOP	Process should be followed the standard	Prod Floor	Nov 2021	QA Team	Check SOP in all areas
		SOP not available	Provide SOP	Operator should be followed SOP	Prod Floor	Nov 2021	QA Team	Check SOP in all areas
4.	Material	Raw Chemical expired	Check quality of raw chemical before using	Ensuring the quality of raw chemical should be followed the spec	Warehouse chemical	Nov 2020	QA Team	Doing physical test of raw chemical in Lab
		Rubber preform not drying enough	Check quality of adhesive before using	Ensuring the quality of chemical should be followed the spec	Roll mixing	Nov 2020	Leader	Tight to control prod plan due to rubber preform should be dried enough before send to the next process
5.	Environment	Room temp out of spec	Control room temp every 2 hours	For reducing the C grade rubber outsole.	Prod Floor	Nov 2021	QA Team	Ensuring the room temperature follow the standard

Table 5. Six Sigma and DPMO Level

(Nov 2020 – Feb 2021)

Month	Total Prod (prs)	Total Defect (prs)	% Defect	CTQ	DPMO	SIGMA
Nov	1,478,693	56,603	3.83	5	7,655	3.95
Dec	1,319,612	48,700	3.69	5	7,380	3.9
Jan	1,245,460	42,967	3.45	5	6,899	3.95
Feb	1,149,093	41,245	3.59	5	7,178	3.95
Avg	1,298,214	47,379	3.64	5	7,278	3.95

The data above in table 5 shows that the six sigma level of capability and DPMO after improvement is 7,278.81 and the sigma level is 3.95.

After improvement using the DMAIC method, the data were collected and evaluated. The DPMO value for June - Oct 2020 is 10,395 and the Sigma value is 3.8. Meanwhile, the DPMO value for Nov 2020 - Feb 2021 is 7,278 and the Sigma value is 3.95

Table 6. Data C Grade Rubber Sole
(Nov 2020 – Feb 2021)

Month	Total Prod A Grade (prs)	Weight per pair(kg)	A Grade (kg)	C Grade (kg)	%
Nov	1,275,956	0.37	472,104	16,943	3.4
Dec	1,130,122	0.40	452,049	14,480	3.0
Jan	1,253,364	0.38	470,012	13,113	2.6
Feb	1,163,817	0.36	418,974	11,848	2.7
Avg	1,205,815	0.38	453,285	14,096	2.9

The comparison of the two data mentioned above, namely the DPMO and Sigma value before and after improvement on table 1 and table 5, it can be seen that there is a decrease in the DPMO value by 30%

4. CONCLUSION

Based on the data processing and analysis of this study, the conclusion of the researchers as follows [13]. The highest percentage of the C grade Rubber sole during June 2020 up to Oct 2020, namely Dent (52.5%), Contaminate (29.80%), Color Bleeding (6.64%), Bubble (5.57%) and Lack of material (5.53%). The calculation results before the process improvement, the DPMO value is 10.395 and Sigma t is 3.80. After improvement the DPMO value becomes 7.278 with Sigma t is 3.95. The percentage of C Grade rubber sole is also showed decreased to 2.9%. Because of the analysis of the types of defects on the Pareto diagram showed that Dent had the biggest percentage, namely 52.45%. Therefore, reducing the C Grade rubber sole should be the top priority is Dent.

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