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Quality Control Product to Reduce Loss Chemicals with Six Sigma Methods

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Abstract: ***The oil & gas industry development in the era of globalization is currently growing, so the company in maintaining its business should be able to compete closely with companies that produce the same products. To be able to survive in business competition, maintaining quality is absolute which must be made by the company. Apart from maintaining the quality of the products, companies must also do savings on the production process one is by doing quality control therefore the resulting product does not have a high level of rejects waste against the use of raw materials can be limited in accordance with the standards of the company. PT. X is a labor-intensive industry that is engaged in the production of sports shoes business. This research aims to reduce Loss chemical foxing tape according to standards of the company amounting to a maximum of 6%. The approach used in controlling the quality of the rubber foxing tape is by using the method of Six Sigma. Based on the results of the study obtained DPMO of 1,171.92 with a sigma value of 2.50. And the biggest defect is shrinkage of 32.83% or 11,169 pairs.The cause of shrinkage from the analysis carried out with fishbone diagrams and FMEA are the machines not standard, operators do not run SOP and raw materials expired. Therefore, machine need to be repairs and doing continuous monitoring on whole processes up to finished product.***

Keywords*:* quality control, loss chemicals, six sigma

1. Introduction

Pay attention to the quality of the production process will result in a product that is free from damage. This can avoid waste and ineficiency so that the production cost per unit can be suppressed and the price of products can be more competitive (Windarti, 2014). According to Sukardiet all (2011), improvement of the quality of the production process must be done continuously in order to minimize product defects. One method that can be used to control quality as well as addressing the large number of product defects with six sigma methods (Pandeet all, 2002). Both statements have been proved by Windarti (2014) stating that the concept of six sigma continuous improvement is to reduce defects by means of minimizing any variations that occur in the production process. Windarti (2014) It has also been proved by applying this method to make improvements in the production process of iron-concrete. Six sigma is one of the most popular new method as an alternative in the principles of quality control which is a breakthrough in the field of quality management (Gasperzs, 2005). According to Vanany and Emilasari (2007), the stages of the implementation of six sigma quality improvement consists of five phases of the DMAIC (Define, Measure, Analyze, Improve and Control) method. Six sigma can be used as a measure of system performance industry that lets companies make improvements with amazing breakthrough strategy pre-date. The higher the sigma target is achieved then the performance of the industrial system is getting better. While according to Hendradi (2006), six sigma is a disciplined process that helps to develop and deliver the product approached perfection. Through an emphasis on process capability, the industry can expect 3.4 failures per million opportunities (DPMO Defects Per Million Opportunities) (Latief and Utami, 2009).

The issue of quality has led to the tactics and strategy of the company as a whole in order to have the competitiveness and survive against global competition with products of other companies (La Hatani, 2007). The quality of a product is not an all-round fluke (Prawirosentono, Suyadi 2007). Quality can be defined as the level or size of product compliance with the standard (Alisjahbana Comely, 2005). So, good quality will be generated from a good process and compliance with quality standards have been determined based on the needs of the market. The reality on the ground shows that companies that are successful and able to survive must have had the program about the quality. Because through the good quality of the program will be able to effectively eliminate waste and improve the ability of competing companies. By giving attention to quality will give a positive impact to the business through two ways i.e. impact on production costs and the impact on earnings (Gaspers, 2002 in JuwitaAlisjahban, 2005). However, even though the production process has been implemented very well, in fact it is often still found a discrepancy between the resulting products is expected. It is caused by deviation – deviation from a variety of factors, both derived from the raw materials, labor as well as the performance of the facilities of the machine used in the production process. In order that the resulting product has a quality in accordance with the standards established in accordance with the expectations of the company and the consumer, then the company should undertake activities which have an impact on the resulting quality and avoid the large number of damaged/defective products join sold into the market.

The company's excellence in terms of reducing the consumption of raw materials, waste one of them through the application of quality control with the method of Six Sigma across the entire company. The Six Sigma is one of the ways to make improvements and improved quality in a company. The method of Six Sigma is a way to achieve

the performance of operations with only 3.4 defects (defects) for every one million opportunities or activities. Six Sigma method aims to improve performance, discover and reduce factors cause defects and errors, reduce operating costs and improve productivity, so that the company can be expected to reduce the number of defective product the resulting numbers are quite significant. The higher the sigma target is achieved, the better the performance of industrial processes. Based on the description above, this research needs to be done to analyze the applied quality control efforts by PT. X, knows what kind of disability occurred, how sigma level on the process of making shoes in pt. Sockets X when measured by the method of Six Sigma and find the reason of occurrence of defective product and still looking for a solution to repair, so the number of product defects may be pressed is minimal as possible.

PT. X is an industry that is engaged in the business of sports shoe industry experiencing problems of Loss above the standard chemical company of tolerance throughout the year 2018. During the period January to December 2018, PT X produces as much as 5,996,945 pairs of foxing tape results that are produced, there are errors the product of 10.8%. With this kind of disability products i.e. bubble, burning, scratch and damage.

The study is expected to be known the amount of disability experienced in the process of of the foxing tape. It also calculated the value of the DPMO and Sigma Level at this time. Analysis of the types of defects with the largest percentage of that need special attention or can be prioritized.

2. Methodology

According to Gasperz (2002) that the 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). The value of 1.5 Sigma shift is obtained from the research results Motorolla over the process and industrial system, which according to research results that are as good 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.

The Methodology of *Six Sigma*
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.

According to Gasperz (2002:1) And six sigma is a quality improvement vision towards the target of 4.3 failure per million the occasion for every transaction (goods/services), and is an activity towards perfection. This resulted in the emergence of a sense of understanding of six sigma quality level that other quality level where there is only 3.4 defects resulting from a million chance occurrence of defects (Defects Per Million Opportunity (DPMO), which has been proven by Koeswara (2013) by applying this method on improving the quality of the sandals in CV Sancu Creative Indonesia.

The methods used in this research is descriptive research method to describe or analyze a research results but is not used to make broader conclusions (Sugiyono, 2012). 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 Six Sigma method when applied to the product foxing tape. 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 conducted were:
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. in this stage to use SIPOC diagram to know the process involved, the process sequence and interaction process as well as what is involved in the process.

2) Measure
The second stage, namely measure and calculations of DPMO, the sigma level in order to be known in 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 that is the root cause of the problem that caused the defective product. The use of this tree diagram applies to all types of potential CTQ means that cause the most defects. The data obtained through interviews with the staff of PT. X.

4) Improve
The fourth stage is the stage of explanation i.e. improve step-by-step problem solving disability products rubber sole. The problems already identified and found the root of the problem laid out the design of its repair. At this stage the use of tables is Failure Mode and Effect Analysis (FMEA) for product defect repair plan (Metasari, 2008).

5) Control
The fifth stage or final stage i.e. control that is control when it made efforts in the improvement. Evaluation of all corrective actions that have been done have to know the success of the efforts that have been applied, also so that when new problems arise can be dealt with immediately to prevent greater damage. Counting of DPMO, sigma and value and the cost of the repair effort is done after also apply the method.

3. Results and Discussion

Define
PT. X is a company that produces sports shoes. In the production process in the technical department that produces Foxing tape, there are several types of defects that cause loss chemical, namely shrinkage, c-grade assembly, dust kneader, over cured rubber, quality issue.

Shrinkage
Shrinkage is a defective type due to Foxing tape shrinking after 24 hours of cooling. This creates a loss chemical from Foxing tape.

C-grade assembly
C-grade assembly is a type of defect due to the assembling process. This causes Loss chemical because the technical department must reproduce foxing tape.

Dust Kneader
Dust Kneader is a loss chemical that occurs due to a chemical reduction during the process due to engine leakage.

Over cured Rubber
Over cured rubber is a type of defect caused by foxing tape that cannot be recycled because of the type of machine that does not support it. This can be overcome by installing a device to adjust the engine speed when operating.

Quality issue
Quality issue is a type of defect that results in a loss chemical. Because Foxing tape has exceeded the time limit for recycling. Foxing tape can be recycled if the production time after the process of adding chemical sulfur does not exceed 4 days.

Table 1: Loss chemical of Foxing tape 2018

Month	Qty Prod (pairs)	Chemical usage (kg)		Loss chemical	
		Standard	Actual	Kg	%
Jan	429,400	91,460	113,785	22,325	24.4
Feb	425,020	90,763	103,186	12,423	13.7
March	461,356	97,922	108,066	10,144	10.4
Apr	492,325	97,579	107,370	9,791	10.0
May	416,957	84,783	93,117	8,334	9.8
June	277,881	56,132	61,524	5,392	9.6
July	474,448	101,912	114,083	12,171	11.9
Aug	493,166	110,073	120,560	10,487	9.5
Sept	487,577	104,733	113,921	9,188	8.8
Oct	588,292	127,347	137,696	10,349	8.1
Nov	601,059	134,012	143,663	9,651	7.2
Dec	580,345	127,524	136,389	8,865	7.0
Total	5,727,826	1,224,240	1,353,360	129,120	10.5

At this stage will be determined problems occurred that resulted in the Loss of the chemical over the standard of tolerance of the company namely 6%. The data used is data loss chemical of foxing tape in year 2018.

Table 2: Defect type of Loss chemical Foxing Tape 2018

Month	C-Grade of Assembly (kg)	Qty reject (prs)	Dust Kneader (kg)	Qty reject (prs)	Over cured rubber (kg)	Qty reject (prs)	Quality issue (kg)	Qty reject (prs)	Shrinkage (kg)	Qty reject (prs)
Jan	7,122	1,852	1,688	439	8,717	2,266	255	66	4,543	1,181
Feb	2,624	682	1,349	351	4,867	1,265	77	20	3,506	912
Mar	2,897	753	1,297	337	1,868	486	256	67	3,825	995
Apr	2,329	606	1,843	479	1,107	288	450	117	4,062	1,056
May	1,978	514	872	227	1,762	458	282	73	3,440	894
June	1,357	353	513	133	1,024	266	204	53	2,293	596
July	3,761	978	1,596	415	940	244	1,960	510	3,914	1,018
Aug	3,651	949	1,622	422	1,439	374	1,695	441	2,034	529
Sept	2,508	652	1,655	430	1,345	350	297	77	3,383	880
Oct	2,943	765	1,939	504	1,232	320	515	134	3,720	967
Nov	2,835	737	1,966	511	896	233	476	124	3,479	905
Dec	2,230	580	1,986	516	772	201	884	230	4,760	1,238
Total	36,235	9,421	18,327	4,765	25,969	6,752	7,351	1,911	42,959	11,169

Measurement

Calculation of Defect Per Million Opportunities (DPMO) and Sigma Values.

The results of the calculation to find out the value of the DPMO (Defects Per Million Opportunity) and Sigma values shown on table 3.

Table 3: Table DPMO and Sigma Values

Month	Qty Product (pairs)	Qty Reject (pairs)	CTQ	DPMO	SIGMA
Jan	429,400	5,804	5	2,703.30	2.5
Feb	425,020	3,229	5	1,519.45	2.5
March	461,356	2,637	5	1,143.15	2.5
Apr	492,325	2,545	5	1,033.87	2.5
May	416,957	2,166	5	1,038.96	2.5
June	277,881	1,401	5	1,010.50	2.5
July	474,448	3,164	5	1,333.76	2.5
Aug	493,166	2,726	5	1,105.51	2.5
Sept	487,577	2,388	5	97.79	2.5
Oct	588,292	2,690	5	914.51	2.5
Nov	601,059	2,509	5	834.85	2.5
Dec	580,345	2,304	5	794.01	2.5
Total	5,727,826	33,563	5	1,171.92	2.5

Equation (1) is used to obtain the DPMO:

$$DPMO = \frac{\text{Qty Defect}}{(\text{Qty Prod X CTQ})} X1.000.000$$

Where:
CTQ = Qty defect type

Equation (2) to get the Sigma Value:

$$\text{Sigma values} = \text{NORMSINV}\ \frac{(1.000.000 - \text{DPMO})}{1.000.000} + 1.5$$

Data processing with Pareto Diagram

To find out the critical process, Analysis by Pareto diagram carried out with using the reject data of foxing tape. From Table 3 and Figure 1, it can be seen that shrinkage is the biggest defect of 4.0%. For that shrinkage is prioritized in this study.

Table 3: Data Prosentase Defect Foxing tape

Reject type	Qty Reject (pairs)	%	Cumulative
Shrinkage	11,169	32.83	32.83
C-grade assembly	9,421	27.70	60.52
Over cured rubber	6,752	19.80	80.36
Dust kneader	4,765	14.00	94.36
Quality issue	1,911	5.60	100.00
Total	34,018	100.00	

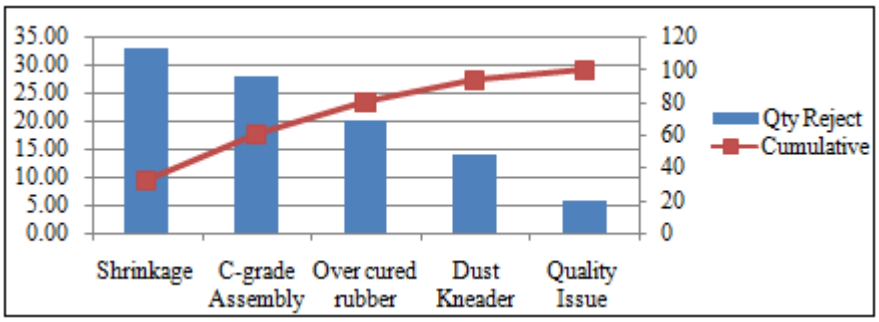

Figure 1: Diagram Pareto

Analyze: Fishbone Diagram

From reject type analysis and Pareto diagram Figure 2 shows that shrinkage is the biggest defect, which is as much as 32.83%.

After discovering the causes of shrinkage, a Fishbone Diagram is made as shown in Figure 2.

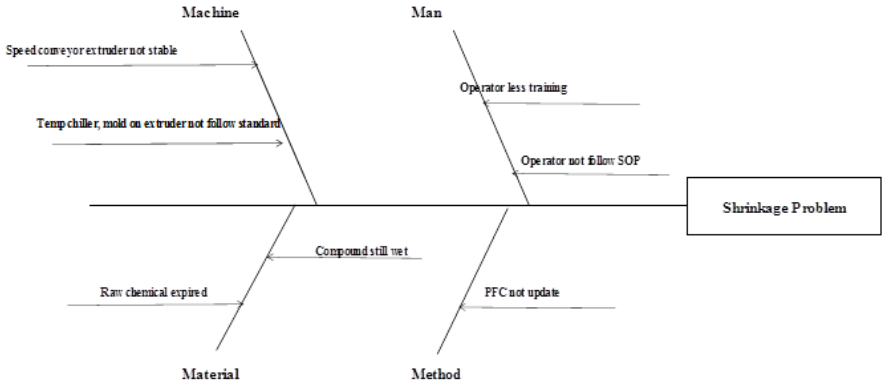

Figure 2: Fishbone Diagram

To find out the factors that cause shrinkage defects, the main causes can be searched categorized into 4 factors, namely:

Man

The main cause of disability from human factors is the lack of skill of operators and operators not running the Standard Operating Procedure (SOP).

Method

Process Flowchart that doesn't update causing problems during the production process is the problem detected.

Material

Raw chemicals that have expired cause problems in the production process. Likewise with the still wet compound already used. Both of these were detected in the production process.

Machine

From the machine factors several things that need to be considered are the speed of the extruder machine that is unstable and the temperature of the chiller and mold that cannot be controlled due to the absence of an indicator on the extruder machine.

Environment

Environmental factors have no influence on the shrinkage.

Improvement: Failure Mode and EffectAnalysis(FMEA)

The next step is the improvement stage using the FMEA tool (Failure Mode and Effect Analsis). FMEA is used to identify problems that can eliminate or reduce products reject. Through FMEA we can find out potential problems that must be addressed by calculating the Risk Priority Number (RPN) so that the repair phase can be carried out.
The following describes the level of product defects using the FMEA table:

After observation and direct interviews with operators and

production leaders, the causes of defects in Foxing tape products can be known. By using FMEA (Failure Mode and Effect Analysis), it can be seen that the greatest RPN (Risk Priority Number) value is obtained from the unstable speed of the extruder conveyor, resulting in reject Foxing tape, which is obtained by a value of 162.

Next steps will be taken to reduce or eliminate Shrinkage defective products:

1) Installing engine speed regulators in order to the speed can be adjusted and standardized for consistency.
2) Replace spare parts of machines that are already worn out and perform TPM the machine periodically.
3) Conduct training to operators regularly.
4) Conducting routine inspections of operators following SOP and process monitoring is carried out regularly.
5) Ensure that the PFC used is updated before mass production.
6) Inspect the chemical expiration date before use.
7) Ensure the compound is in a dry condition before continuing in the next process.

Table 4: FMEA Causes Shrinkage

Expected Product Characteristic	Mode of Failure	D	Cause of Failure	O	Effect of Failure	S	RPN	Rank
Shrinkage fit the standard	Engine condition abnormal	8	Speed conveyor extruder not stable	9	Shrinkage of foxing tape is not fit the standard	9	648	1
	Engine and mold condition abnormal	6	Temp chiller mold not follow the standard	7	There are engine machine that are worn out	8	336	3
	Poor operator capability	4	Incorrect setting machine	3	Lack of operator knowledge in setting machine	3	36	5
	SOP is not follow	2	Product defect and result product is not fit the standard	2	Incorrect procedure in operating the machine	2	8	7
	PFC is not updated	3	Product defect and result product is not fit the standard	4	Incorrect procedure in operating the machine	4	48	4
	Raw chemicals is not standard	7	Raw chemical expired	7	Foxing tape is not standard	8	392	2
	Compound is not standard	3	Compound is still wet	3	Compound drying time is not standard	3	27	6

4. Conclusion

From the results of the data processing and analysis that has been done, then it can be summed up some of the things that is foxing tape production data in 2018 as much as 5,727,826 pairs with the amount of damages as much as 33.563 pairs. The types of defects that occurs is shrinkage (32.83%),c-grade assembly (27.7), over cured rubber (19.8), dust kneader (14.0%) and quality issue (5.6%).Then, from the calculation results obtained DPMO value of 1,171.92 with Sigma Level of 2,50. Analysis of the types of defective foxing tape and Pareto diagram showed that shrinkage defects were defective with the highest percentage of 32.83%. Therefore, to reduce loss chemical foxing tape, shrinkage problems must be a top priority for improvement.

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