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Quality Control on Minimizing Defect Product on 20 OE Yarn

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Abstract. *Industrial businesses in Indonesia realize that consumer desires have changed over time. Consumers desire that becomes the main priority is quality. PT. Bitrate Industries, as a company that produces yarn in Semarang, always strives to improve product quality to the desires of consumers. The company faces quality control problems: the production process of 20 OE yarn, producing the highest defective products. The Six Sigma approach analyzes the causes of defects, identifies sources of variation, proposes improvements with 5W + 1H, and implements a quality control plan. Most defects occur in the production process in the autocross engine, which is caused by engine wear. Implementation of the kaizen approach can be given proposals in the form of improvements in maintenance, according to the existing scheduling and periodic replacement of parts. This study concludes that the proportion of defects is still in the controlled stage, but the quality control of the product is still needed. A quality improvement project with a Six Sigma approach can benefit any company that needs to find the most efficient way to improve product quality.*

Keywords*: Six Sigma, Kaizen, 5W+1 H, Quality Control, 20 OE Yarn.*

I. INTRODUCTION

At this time, industrial business players in Indonesia realize that consumer desires have changed over time. Consument desires, the top priority is quality, both in service and the products produced. In the industrial world, competition intensifies, companies must survive and compete with similar companies. Consumers have put pressure on the industry for the products they purchase to have a higher value. The industry which adopts various quality management tools and concepts drives better product quality with lower costs. This adoption leads to the adaptation of different quality management concepts into the company's production (Joshua Chan Ren Jie et al., 2014). In addition to emphasizing the products produced, it is necessary to give more attention to the quality in the production process (Ariani, 2003).

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According to Sukardi et al. (2011), quality improvement in the production process must be carried out continuously to minimize product defects. The commitment of the company to continue to maintain high quality is by implementing various good management systems, more effective production systems, and trying to minimize the possibility of products not conforming to predetermined specifications (product defects). PT. XXX Industries is a company that produces yarn in Semarang, which always strives to improve product quality towards consumer desires in each of its production. This Factory produces open-end yarn, TC yarn, PC yarn, CVC yarn, and Modal Cotton yarn for single and TFO yarn for double yarn.

Quality is conformance to requirements, which is following the requirements or standards. A product has quality if it conforms to predetermined quality standards. Quality standards include raw materials, production processes, and finished products (Crosby, 1979). It is best if the attention to quality is not on the final product, but on the production process or products that are still in the process (work in process), so that if it is known that there is a defect or error, it can still be corrected. Thus, the final product produced is defect-free, and there is no more waste of time and cost that must be paid dearly because the product must be discarded or

reworked. This quality can be achieved by determining applicable methods, including statistical techniques and others (Gaspersz, 2003). To produce a good quality product, the variations that occur must be minimized. Solve the problem of product defects, and not all causes can be resolved at once. The company must be able to identify what issues need to be prioritized first. Therefore, we need a method to overcome these problems (Shanty, 2012).

One method can control quality and overcome the number of defects in the six sigma method (Assarlind et al., 2012). In statistical terms, Six Sigma means 3.4 defects per million opportunities. Sigma is the standard deviation of data in statistics. In addition, sigma is a measure of variability which illustrates that the data is still in the statistical distribution of the mean (average) value. Six Sigma's goal is to unify all operations across manufacturing steps to produce the desired results. It is a disciplined and structured approach that focuses on constantly providing the perfect product or service to customers (Akhil Khajuria et al., 2018). Dewi (2012) has proven that by applying this method to make quality improvements in the yarn manufacturing industry.

Dewi (2012) states that the six sigma concept is a continuous improvement to reduce defects by minimizing variations in the production process. Although Six Sigma originated in manufacturing in the late 1980s, this concept has been successfully applied in a wide variety of fields, including healthcare, information technology, distribution operations, healthcare, supply chain management, inventory management, education, construction, warehouse, etc. to improve processes and to correct inefficiencies (Mazen Arafeh et al., 2017).

According to Vanany and Emilasari (2007), the six sigma quality improvement implementation stages consist of five phases, namely defining, measuring, analyzing, improving, and controlling (DMAIC). 5 why, cause and effect, Pareto analysis, change management tools, histograms, control charts and scatter diagrams are a common set of tools that can be used interactively between Lean and Six Sigma. The main benefits of implementing Six Sigma include increased profit and financial savings, increased customer satisfaction, reduced costs, reduced cycle times, improved vital performance metrics, reduced defects, reduced machine downtime, reduced inventory, improved quality, and increased production capacity. However, this must be balanced with individual abilities because Six Sigma is only a tool, and the people implement it (Muraliraj et al., 2017). Six Sigma can measure industrial systems' performance to make tremendous improvements with actual strategic breakthroughs. The higher the sigma target achieved, the better the industrial system performance is. Therefore, this study uses the six sigma approach and 5W + 1H to determine quality control in the yarn production process and suggest improvements.

II. RESEARCH METHOD

The location of this research was conducted at PT. Bitrate Industries, Semarang from 5 August to 31 August 2019. The following are the stages of data analysis using the six sigma method and 5W + 1H.

Define Stage

Define is the first stage in the concept or program for improving the quality of the Six Sigma method. The first operational step that will be carried out is to determine the goals and objectives of quality improvement and identify product defects. Before defining the key processes and customers in a Six Sigma project, knowing the SIPOC process model (Supplier, Input, Process, Input, and Customer) is necessary.

Measurement Stage

The measure is the second stage in the six sigma method. This measurement stage is carried out in 2 stages, namely: determining the proportion of the most dominant defects that will qualify as CTQ (Critical to Quality) using the Pareto diagram, and then calculate the process capability (sigma) and DPMO (Defects Per Million Opportunities). This sigma capability measurement is carried out to determine the

process capability of the identified defect products.

Analyze Stage

After obtaining data at the define stage and measure stage, the third stage identifies the causes of quality problems. This stage can be done using the p control chart (P-Chart), determining whether products are outside the control limit.

Improve stage

This stage is the stage of improving the process and eliminating the causes of the defect. The steps to carry out quality improvement can use Kaizen implementation tools, including Kaizen Five-Step Plan, Five W, One H, and Five-M Checklist.

Control stage

This stage is the last operational stage in a six sigma quality improvement project. At this stage, the results of quality improvement are disseminated, successful best practices in improving the process are standardized and made standard work guidelines, and ownership or responsibility for the process, which means that six sigma ends at this stage.

Kaizen Implementation Tool

Kaizen is a term in Japanese for the concept of Continuous Incremental Improvement. Kai means change, and Zen means good. Kaizen means a continuous good change that involves everyone. This approach only works well when accompanied by the right human resource effort because people are the most critical dimension in improving quality and productivity. There are four kaizen implementation tools. The first kaizen checklist, which is to identify problems that can describe opportunities for improvement, is to use a checklist of factors that are likely to need improvement. Second, namely, the kaizen five-step plan, which is the approach used by Japanese companies. This step is often called the 5-S movement, which is the initials of Japanese words: Seiri, Seiton, Seiso, Seketsu, and Shitsuke. Third, the implementation of Kaizen is done using the 5W + 1H tool. Five Ws and one H are used widely as management tools in a variety of environments. Five Ws and one H, namely Who, What, Where, When, Why, and How. The fourth, the five m checklist, focuses on the five critical factors involved in each process: man, machine, material, methods, and measurement. In each process, improvement can be made by examining aspects of the process.

III. RESULT AND DISCUSSION

Define Stage

At this stage, determine the goals and objectives of improvement. The object of this research is 20 OE (open end) threads because this product is a product that is produced for a whole month in July 2019. From the standard specifications set by PT. Bitrate is still found products that have defects or, in other words, do not meet the quality standards that have been set. Defects in 20 OE threads include (crossing, breaking, dirty, hard rolls, loose rolls, bad rolls, ex yarn, broken cheese, over doffing, underweight, lapping).

Measure Stage

At the measuring stage, identify potential Critical to Quality (CTQ) that affects product quality from predetermined specification standards. CTQ is a measurable characteristic of a product or process that must reach the standard or limit of the specification. The number of 20 OE yarn production in July 2019 was 10,669 cones with defects of 1,061 cones. Pareto diagram making is used to determine the most dominant defect, which will later be identified as CTQ so that you can find out the type of defect that must be repaired immediately. The results of the Pareto diagram can be seen in Figure 1.

The diagram shows the types of defects that often occur or identify the CTQ sequence with the details of the defect over doffing as many as 582 cones, less weight as much as 156 cones and bad rolls as many as 98 cones. Attribute data is often in the form of categories or classifications such as good or bad, success or failure, and so on. The number of Defects can be used as a table

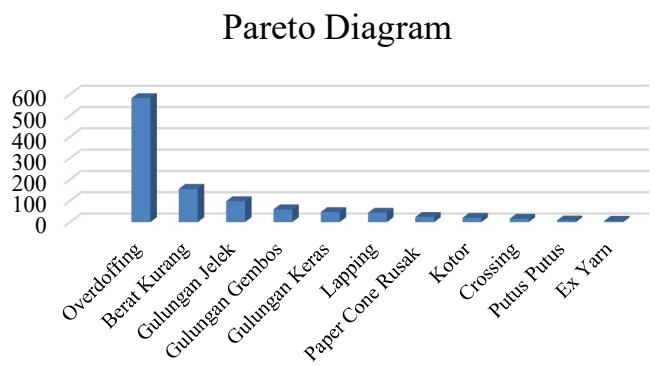

Figure 1. Pareto Diagram

Table 1. Potential CTQ Sequences

No	Type of Defect	Number of Defects	Cumulative Defects	Percentage (%)	Cumulative Percentage (%)
1	Over doffing	582	582	54.85	54.85
2	Less Weight	156	738	14.70	69.56
3	Poor Roll	98	836	9.24	78.79
4	Deflated Roll	60	896	5.66	84.45
5	Tight Rolls	47	943	4.43	88.88
6	Lapping	44	987	4.15	93.03
7	Broken Paper Cone	24	1011	2.26	95.29
8	Dirty	20	1031	1.89	97.17
9	Crossing	16	1047	1.51	98.68
10	Disconnect	8	1055	0.75	99.43
11	Ex Yarn	6	1061	0.57	100.00

according to the CTQ potential with the highest defect. Potential CTQ sequences can be seen in Table 1.

The next step is to calculate the DPMO value, which will later be converted into the sigma value capability. DPMO is a performance measurement of the process capability assessment.

The calculation shows that the DPU (Defects Per Unit) value is 0.099 from the division between the number of defective products and the total sample. After the DPU value is known, you can find the DPMO value by multiplying the DPU value by one million and dividing it by the CTQ, which is eleven. The results from DPMO during July 2019 amounted to 9097.48. The results of the calculation of the DPMO value after being converted into a six sigma value produce a sigma value of 3.86. This value represents that after one million products of 20 OE yarn are produced. It is possible to obtain 9,098 defective or defective threads following the specifications set by the company. This is still far from the expectation of realizing zero failure. However, it is still included in the efforts to improve quality towards zero defects to provide total satisfaction to customers.

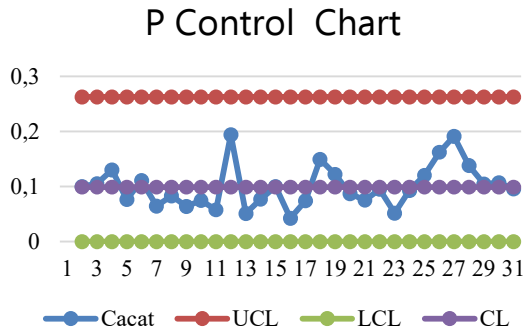

Figure 2. P Control Chart

Table 2 Sigma Capability Level

No	Number of Products	Number of Defects	Number of Potential CTQ Causes Defects	DPM	Sigma
1	430	43	11	9090.91	3.86
2	284	30	11	9603.07	3.84
3	376	49	11	11847.20	3.76
4	300	23	11	6969.70	3.96
5	288	32	11	10101.01	3.82
6	373	24	11	5849.38	4.02
7	288	24	11	7575.76	3.93
8	392	25	11	5797.77	4.02
9	360	27	11	6818.18	3.97
10	380	22	11	5263.16	4.06
11	288	56	11	17676.77	3.60
12	392	20	11	4638.22	4.10
13	376	29	11	7011.61	3.96
14	380	38	11	9090.91	3.86
15	352	15	11	3873.97	4.16
16	392	29	11	6725.42	3.97
17	388	58	11	13589.50	3.71
18	384	47	11	11126.89	3.79
19	368	32	11	7905.14	3.91
20	384	29	11	6865.53	3.96
21	304	29	11	8672.25	3.88
22	368	19	11	4693.68	4.10
23	376	35	11	8462.28	3.89
24	382	46	11	10947.17	3.79
25	320	52	11	14772.73	3.68
26	392	75	11	17393.32	3.61
27	318	44	11	12578.62	3.74
28	324	34	11	9539.84	3.84
29	364	39	11	9740.26	3.84
30	376	36	11	8704.06	3.88
Jumlah	10699	1061	11	9097.48	3.86

Table 3 Description of Formulas

Notation	Formula
PDF	= Number of Defects/Total Sample
DPM	= DPU*1000000/Number of CTQ
Sigma Value	= normsinv((1000000-DPMO)/1000000)+1.5

Analyze stage

The image p control chart can be interpreted as a cyclic pattern. This pattern can arise due to the environment, for example, changes in temperature, electric voltage, shift operator.

But it can also be caused by other than the environment, such as operator fatigue and tool wear. The p control chart shows that the process capability can meet the expected tolerance limit specifications, which means that the proportion of 20 OE yarn defect products is still in a controlled stage. No point is uncontrolled other than the point exceeding the upper and lower control levels (exceeding 3). However, there is still a need for quality control of the product.

Improvement Stage

The next step is to develop improvement steps using the 5W + LH method. At this stage, it relates to ways that can be done to minimize or

even prevent the product from defects. Improvements are obtained from solutions based on the measurement results and analysis stages in the previous stages. The most significant contribution to the occurrence of defects in the yarn and being a priority for improvement steps is the type of defect over doffing, underweight, and bad rolls. In the 5W + 1H table, what column describes the type of defect, why column explains the cause of the defect, where the defect occurs, when the queue, when the defect occurs, who column about, who needs to repair, and how to take corrective action. The action plan to improve Six sigma quality can be seen in Table 4.

Based on the root causes determined through 5W + 1H, one solution that deserves to be discussed to reduce or eliminate the root of the problem is engine repair, both from an electrical and mechanical side. The electrical side includes improvements to the PCB to synchronize the counter sensor and the diameter sensor. In contrast, from the mechanical side, it includes the replacement of spare parts. What needs to be considered is the mechanical repair of machines because many machines experience part wear. After all, spare parts are used continuously even though they have experienced wear. This repair requires firmness on the company's part to continue following the scheduling of machine maintenance to minimize defective products. The machine maintenance schedule is replacing worn parts and cleaning the machine from cotton scraps because that is also one of the causes of defective products.

Engine repair solutions are essential because this is the root of the problem that causes over doffing as the highest defect caused by wear of parts and contributes ± 80% of defects from all

Table 4. 5W+1H *Over doffing*

What	Why	Where	When	Who	How
Over doffing (Weight +)	- The diameter sensor fails to detect causing the automatic cut process not to work. - The magnet which measures length doesn't function properly normal	Autocor Machine 4 SE 8 Corolab	Juli 2019	Mechanic & Electrician	- Repair PCB for synchronizing counter and diameter censor - Schedule for spare part changing

Table 5. 5W+1H Less Weight

What	Why	Where	When	Who	How
Weight (-)	Stain material causing measuring head automatically cut thread impact to increase of thread connection.	Autocoro Machine 4 SE 8 corolab	Juli 2019	Operator	Improvement of choosing material quality

Table 6. 5W+1H Poor Roll

What	Why	Where	When	Who	How
Poor Roll	- Attachment between the rotor and twin disk does not fit. - Uncenter Twin disk position. - Loose navel from the adapter. - The bearing tray is worn out. - Stain Rotor - The adapter is thread clogged.	Autocoro Machine 4 SE 8 corolab	Juli 2019	Maintenance Operator	- Check component every scouring and maintenance ensure every component in good condition. - The operator always cleans waste on the machine.

Table 7. 5W+1H Deflated Roll

What	Why	Where	When	Who	How
Deflated and Thigh Roll	- Broken Rubber drum - Spring on package cradle malfunction causing cause Thigh Thread	Autocoro Machine 4 SE 8 corolab	Juli 2019	Maintenance	- Schedule Spare art change

defects that occur in one month. In addition to machine repair, another solution is to improve the quality of the material. This repair is vital because good material will help the machine not cut the yarn too often. This repair causes the defect to be less heavy by cutting too many threads, making the raw materials used inefficient because they are wasted. Skills and accuracy also need to be improved in terms of human resources because getting maximum results depends on the human factor as a machine operator. In addition, operators must frequently control processes and machines to minimize mistakes.

Control stage

This stage is the last operational stage in a six sigma quality improvement project. At this stage, quality improvement results are disseminated, and successful best practices in improving the process are standardized and become standard working guidelines. The benefits of continuous improvement must be obtained in the production process. There needs to be even tighter supervision so we can achieve the desired results. Because the production process is under control, the p control chart can monitor the process over time until problems are found in the process that must be resolved or until the next DMAIC cycle. This improvement step is used for the performance of the following production process, which means that six sigma ends at this stage.

IV. CONCLUSION

From the results and discussion, it can be concluded as follows:

1. The 20 OE yarn production process at PT. Bitrate Industries, namely through blend mat machines, carding, draw frames, and autocoro.
2. Of the total 20 OE yarn production in July 2019, as many as 10,669 cones with 1,061 cones defects with details of 582 cones (54.85%) over offing defects, 156 cones (14.70%) underweight, 98 cones (9.24%) bad rolls).
3. From the calculation of the DPMO value during July 2019, it was 9097.48, and the sigma value was 3.86. This value represents that as many as one million yarn products, it is possible to obtain a defect product of 9.098. The 20 OE yarn production process in July 2019 in the p control chart can be interpreted as a cyclic pattern. This pattern can arise due to the wear of parts. Based on Kaizen implementation tools, proposals for quality control and improvement need tighter supervision and control, especially regarding the wear of components used on autocross machines.

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