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Quality Analysis of Sewing Section in Garment Industry Using Six Sigma

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Abstract: Generally, there are several production processes carried out to produce garment products i.e. cutting, sewing, ironing and packaging. This research found that sewing section of the selected garment factory have defect percentage until 13.28 %. It causes longer production time for remedial activity that decrease the efficiency, so the factory cannot fulfill requirements on time. This study aims to improve performance of garment factory using Six Sigma. Based on the study, it is known that the sigma value of the production process is equal to 3.86 sigma. Some control plans were designed to improve the performance.

Keywords: Quality, Garment, Sewing, Six Sigma.

1. Introduction

The development of the garment industry is now progressing rapidly. Garment industry continually change the design over time based on existing trends. This causes the competition experienced by the garment industry players more stringent. Quality become one of the aspect that is considered by consumers for buying apparel products. So, garment producers should maintain their quality product from the initial process to the final process of apparel product.

Garment manufacturing consist of some section, there are cutting, sewing, ironing and packaging. The first process are cutting fabric in accordance with the design. After that, all material are sequentially sewn to be a final product. Ref [1] and [2] state that defect is common term in apparel industry. According to Ref [1], defect is the loss of time, money and material. This study focuses in sewing section because of highest defect came from this process. This research found that sewing section of the selected garment factory have defect percentage until 13,28 %. A defect product can be classified into two categories, repairable and reject product. Higher defect of repairable item will lead longer production time because of time consuming for corrective action. Once an apparel item being not conform with the requirements, it is need to open the stitch and repair it. This action will take longer time. Whereas for unrepairable product, it will be so costly because the item cannot being delivered to their customers.

Defect products doesn't only affect the production costs but also affect the timeliness of meeting product demands. Based on the historical data of the selected company, there are problems of non-fulfillment of the production targets in July to August 2017. The production target in the period is 924,996 units, while the number produced by the company is only 742,225 units. This is due to the high defect of products that exist in the production process. It caused delay shipments occurring on multiple orders.

That is a big challenge for garment manufacturer to find out the solutionfor reducing defect level. One approach that can be used is Six Sigma. Six Sigma can reduce variation. Six Sigma have five phases of DMAIC, named Define, Measure, Analyze, Improve and Control. Ref [3] and [4] applied six sigma in cutting section in garment industry by using DMAIC approach. Ref [5] also used six sigma DMAIC approach to reduce the occurrence of nonconformities in the carpeting process. This research use Six Sigma to improve the performance of sewing segment.

2. Methods

This study use Six Sigma methods to identify and eliminate waste in apparel production. Six Sigma is a method or technique of quality control that was first adopted by the Motorola company in 1986. Starting in 1988, Six Sigma Motorola became a well-known public knowledge in America [6]. In a narrower statistical sense, six sigma is a quality target that identifies the variability of a process with respect to product specifications so that the quality and reliability of the product can meet even beyond the demands of current customer requirements [7]. Six Sigma is not just a technique but also a philosophy, performance on six sigma means it only produces 3.4 defects of every million opportunities for business processes [8]. The Six Sigma

standard of 3.4 problems per one million opportunities (DPMO) is a response to increasing customer expectations and the increasing complexity of modern products and processes [9].

DMAIC is a closed-loop process that eliminates unproductive process steps, often focusing on new measurements and applying technology for quality improvement toward a six sigma target. DMAIC consists of five main stages [10] :

1) Define. Define is the first phase of DMAIC that determines customer problems, processes and requirements.
2) Measure. Measure is the second phase of DMAIC that aims to identify key measurements of effectiveness, efficiency and translate into six sigma concepts.
3) Analyze. Analyze is the third phase of DMAIC that aims to identify the root causes of possible variations in the process.
4) Improve. Improve is the fourth phase of DMAIC. This stage is done by determining action plan (action plan) to carry out six sigma quality improvement.
5) Control. Control is the last phase of DMAIC. This stage of documented quality improvement results as well as successful best practices in improving the process are standardized and disseminated.

3. Research Methodology

This study aims to find out the proposed improvement of sewing production process in order to reduce or eliminate the existing waste of defective products and idle time.

1) Preliminary Study
   The preliminary study in this study is divided into field studies and literature studies. Field studies were conducted with observations on the production process found in a garment manufacturer located in Semarang, Central Java, Indonesia.
2) Identify the problem
   This stage is a preliminary stage in the research that is identifying problems occurred. The problem that focuses on this research is the existence of waste in the form of defect product and idle time.
3) Data Collection
   Data collection is conducted by observe the production floor, collect secondary data, and interview the supervisor and operator. Observation in production process is conducted to gather all of information that is needed to arrange the value stream mapping. Secondary data that are collected consist of production quantity and number of defect. Interview are conducted to gather information about the quality issues and additional information about the causes of the occurrence of nonconformities.
4) Data Processing
   In this research, data processing is done by using six sigma approach with DMAIC method. In data processing done from define stage until measure stage. Define is to identify the course of the production process described by a value stream mapping diagram. Measure is the calculation or measurement of existing production system in the company by construct Pareto diagram, determining critical-to-quality (CTQ), sigma level calculation and line balancing efficiency calculation.
5) Analysis and Improvement
   In this research, the analysis and improvement is done from the stages of DMAIC that is the analyze stage and the improve phase. Analyze is to identify the factors that cause problems that arise in the production process in the form of waste for high defects and idle time products. Improve is to provide recommendation improvement of the results of data processing and analysis has been done to reduce or eliminate the number of defective products and idle time.
6) Conclusion
   The conclusion is obtained from the collection, processing and analysis of the data.

4. Result and Discussion

4.1 Define Phase

In order to produce clothing products there is a sequence of processes that start from picking material from warehouse, cutting, sewing, ironing to the packaging and products ready to be sent to consumers. This research will focus on sewing process of sport wear product. Sewing process consist of 14 activities, there are given in **Table 1**.

Table 1: Operations of sport wear product

No	Operation
1	Tie the shoulder part
2	Sew the arm on the arm hole
3	Sew the side
4	Cut and attach collars to collar holes
5	Sew collar on collar body
6	Put a label on the collar body
7	Attach elastic to the collar body
8	Cover the elastic on the collar body
9	Lock the elastic stitches for the lower end of the shirt
10	Sew elastic to the lower end of the shirt
11	Lock the stitches on the elastic for the ends of the arms
12	Sew elastic to the end of the arm
13	Sewing care label
14	Lock the stitches at the ends of the sleeves and under the clothes

4.2 Measure Phase

At this stage, the company's production system performance were measured.

1) Pareto Diagram

Pareto diagrams are used to identify the types of defects that are potential to cause product failures. It shows the probability of the magnitude of the defect for each type of defect that appears. Data of defect given in **Table 2**. while Pareto diagram illustrated in **Figure 1**.

Table 2: Data of Defect

No	Type of Defect	Amount (Pieces)
1	Broken Stitch	477
2	Skipped Stitch	285
3	Uneven Cover Stitch	106
4	Open Seam	58
5	Seam Puckering	87
6	Twisted, Wavy, Uneven Body	110
7	Needle Holes	46
8	Fabric Raw Edge	387
9	Bar Tack Missing	42
10	Chalk Mark or Pen	124
11	Untrimmed Sewing Threads	441
	Total	2163

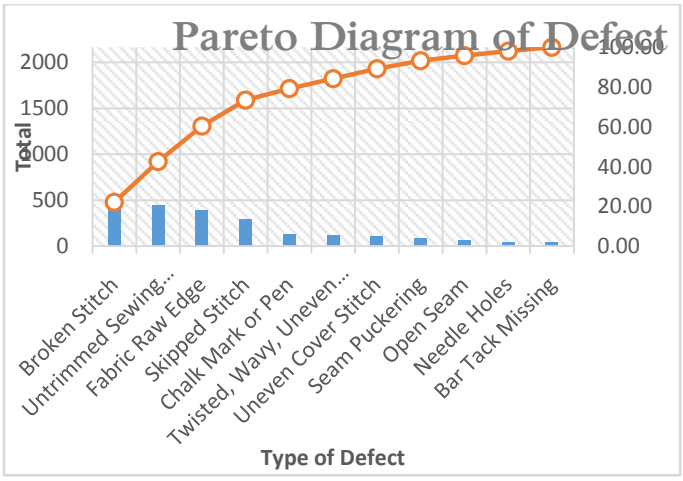

Figure 1: Pareto Diagram

There are 11 types of defects that appear in the production process of sewing. Based on the Pareto diagram can be known that the type of defect that most often happen is broken stitch.

2) Critical-to-quality (CTQ)

Based on the Pareto diagram there are 11 types of defects that can be potential cause of product failure, so there are 11 CTQ.

3) Sigma Level

Sigma level is used to determine the level of quality of a company in producing its products. To know sigma level, DPMO value calculation must be done. Based on the calculation results obtained DPMO value of 8,963 and sigma value in the production process that is equal to 3,86 sigma.

4.3 Analyze Phase

This stage is an analysis to identify the source and root cause of problems that occur in clothing production process using cause and effect diagram. The cause-and-effect diagram of this study was made to analyze the root cause of the problem of the type of defect that often arises and has the greatest potential i.e. broken stitch.This analysis is carried out on the five factors including human factors, machines, methods, materials and work environment. Based on results of interview with production staffs, the causal and effect diagram can be seen in **Figure 2**.

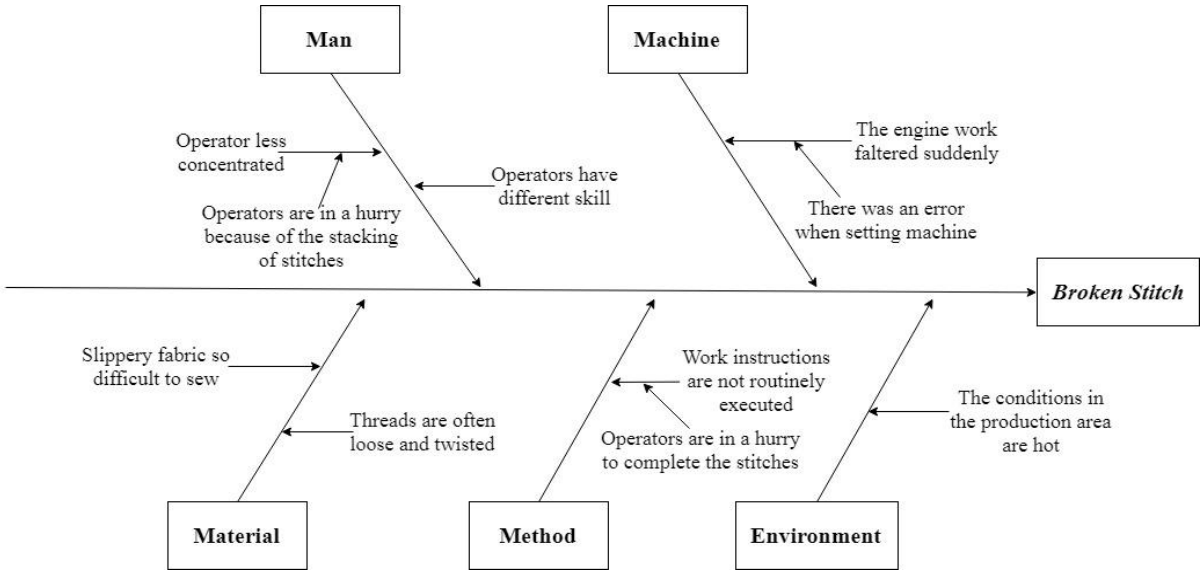

Figure 2: Fishbone Diagram

1. **Man**
   - Operator have different skill
     Operators who have worked longer will have more advanced sewing skills and skills compared to new operators. So there is a need for regular training to be able to have good skills in working and reduce the occurrence of errors during the production process.
   - Operator have less concentration
     Commonly happen that operators have lack concentrate while doing their work. This problem is caused by the operator in a hurry in completing the stitches. This is because the workload is imbalanced and causes a buildup of stitches which causes the operator to process the next process. In addition, it can be due to other factors such as fatigue and saturation felt by the operator for doing the same activity for several hours
2. **Machine**
   - The machine is faltered suddenly
     Sewing machines are often suddenly choked up. This is caused by the occurrence of errors when setting the machine, especially the tension or voltage setting part of the thread. If the engine tension is too tight then the thread will break easily otherwise if the engine tension is too loose then the thread will easily wrinkle which causes the engine to falter. Besides that it is also due to the lack of attention in maintenance for the machine.
3. **Material**
   - The material is slippery so it is difficult to sew

- Yarns often loose and twist
  During the sewing part production process, it is often seen that the operator fixes the position of the thread because the yarn is wrapped around so that the stitch results are not neat. In addition, the threads on the sewing machine are often loose, which interferes with the sewing process

4. Method

- Work instructions are not carried out routinely
  The company has made work instructions that should be followed by the operator so as to facilitate operator performance and avoid mistakes. But often operators do not carry out the method according to work instructions

5. Environment

- The air inside the production area is hot
  Little number of ventilation causes the air flow in the production area to not flow properly so that the air becomes hot.

4.4 Improve Phase

This stage is aim to search solution in order to reduce defect number. There are some improvement plan based on the cause of problem.

1. The new operators will train to increase their sewing skill
2. The operators are trained to control the speed of the machine.
3. Check and maintain the machine periodically.
4. Balancing the line
5. Adding the number of exhaust fan

4.5 Control Phase

The control phase is a step that ensuring the improvements will continue to be implemented in other processes. The process control plan should be a system to monitor the solutions that have been implemented, including methods and metrics for periodic audits. There are some control plan:

1. The workers of garment industry must be given training on a continuous basis on the issue of quality.
2. The management should give higher remuneration for high quality performance.

5. Conclusion

1. Based on the observations on the production process, especially the sewing section found eleven types of defects such as broken stitch, skipped stitch, uneven cover stitch, open seam, seam puckering, twisted wavy and uneven body, needle holes, fabric raw edge, bar tack missing, chalk mark or pen, and untrimmed sewing threads. Of the eleven types of defects the most common type of defect is the broken stitch of 477 of the total number of defects in the overall product of 2.163.
2. Wastage analysis is done using cause and effect diagram. From the result of causal diagram there are five factors causing the problems of human factor, machine, material, method and work environment. From human factor found root cause of problem that is operator have different skill and operator less concentrate. Furthermore from the machine factor that is machine often choked up. Then from the material factor is an unruly fabric and the yarn is often loose and twisted. From the method factor is work instructions that are not run regularly. Last of the working environment factor is the condition of the hot production area.
3. Proposed improvements for production quality improvement are giving sewing training for new operator, giving a training to control speed of machine, balancing the line, checking and maintenance of machine and adding the number of exhaust fan.

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