Quality Control Analysis With Statistical Quality Control (SQC) Approach on Teresia Convection Business Product

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Abstract. The business industry, especially clothing, is an industry that has a significant increase in new entrants every year. Good quality goods are the target of online and offline consumers. This makes entrepreneurs have to pay attention to quality compared to other things. While running their business, Teresia's SME often encounters several problems such as damage to the sewing machine, poor quality materials, and operators who make mistakes during clothing production. From these problems in this study, several methods were used to identify problems and solve them. Starting from finding the value of defects in the production process using the Statistical Quality Control approach. Then the calculation of the sigma value found that the average production process in Teresia SME is 3.49, this means that every production period 15-35% of the production results in cost losses. It must immediately find the root of the problem by using a fishbone diagram. By describing the problem of each aspect of a seam defect whose priority has been calculated using a Pareto diagram, the main problem can be determined. From the results of the RPN on the FMEA method, the problem that causes sewing defects in the production process at Teresia UKM is a worn or old sewing machine. Therefore, it is necessary to plan a repair schedule on the sewing machine. From the results of calculations using the MTTF method based on the calculation of the distribution of damage using easy fit software, the MTTF value is 2 days or 48 hours. That way, it is possible to plan a preventive maintenance schedule on the Pegasus W500 overdeck sewing machine from August to October 2022.
Keywords: UKM, Convection, *Quality Control, Statistical Quality Control*, *Preventive Maintenance*

1. Introduction

As a business owner, your goal is to make as much profit as possible. But to achieve this goal is not easy because it is influenced by several factors such as production errors, management, marketing and others. In the production process, quality is the most basic factor for customer satisfaction. In producing an item, of course, business owners must pay attention to quality with the aim of fulfilling consumer desires. To produce good quality products, production quality is one of the main concerns carried out by companies from raw materials, production processes to final products. Teresia SME is an SME engaged in the clothing industry, especially convection [1]. Teresia's SME is an example of a clothing business that is still operating, given the difficulty of doing business when going through the Covid-19 period, which made many other businesses close. While running their business, Teresia's SME often encounters several problems such as damage to the sewing machine, poor quality materials, and operators who make mistakes during clothing production. All of these things often happen, and the result is that the quality of the clothes produced are not up to standard usage. For this purpose, in this study, the application of Statistical Quality Control (SQC) was carried out to analyze the quality of the production. That way it can open views for researchers, especially SME owners, who will later be given recommendations on the quality of their products. To minimize the occurrence of product defects that

result in a bad reputation and decreased profits and increase customers if the quality of the clothes produced is getting better over time.

2. Method

Production Historical Data

This research was conducted to determine the level of production quality of Teresa's SME by analyzing the results of its production in certain periods. In this study, historical production data from April to May were obtained, which amounted to 7293 units. And also obtained the number of defects each period which amounts to 670 units.

Method of Data Collection and Stages of Analysis

In this study, the data taken were primary data collected from observations and interviews with the main sources, namely business owners. The data taken are historical production data whose data is taken by direct observation for several periods. The causes of production defects were obtained from interviews with resource persons. The description of the root causes of the problem obtained from interviews with business owners and operators. Then the value weighting to determine the priority of the problem carried out by business owners and operators. As well as machine damage data taken from observations of business owners and machine operators. From this analysis, we found a way to reduce the occurrence of product defects in the settings, namely by making a repair schedule to prevent engine damage that results in product defects.

3. Result and discussion

Production Process Chart

Production is a way to create, produce, and make products or goods. This activity cannot be carried out if there are no materials that can be processed for the production process. To be able to carry out production requires human labor, natural resources, capital in all its forms, and skills. All these elements are called the factors of production (factors of production). So, all the elements that support the effort to create value or increase the value of goods are referred to as factors of production [6]. The suit production process at Teresia SME is no different from convection in general. Starting from the bottom, to the finishing stage.

The first stage is preparation, preparation is a stage carried out to prepare various kinds of raw materials and also equipment for the production process. The second stage is making clothing patterns, this stage aims to make it easier for tailor operators when uniting several material components to become clothes. Size adjustment on clothing aims to determine the length and width of the clothes to be produced. In this size adjustment, the operator will make the size of the clothes based on the standards of the body dimensions that have been measured at the pattern making stage. Some of the sizes produced by the operator are Small (S), Medium (M), Large (L), and Xtra Large (XL). Cutting is a stage in the clothing production process, cutting is one of the processes in making clothing components from fabric raw materials before sewing. The next stage after cutting the fabric is the sewing process. Sewing using overlock is done to join the front and back of the garment. The next stage is sewing with a stabbing machine or what is commonly called an overdeck.

The next stage is the installation of rubber in areas that require flexibility. In this finishing process, the buttons are installed using a buttonhole sewing machine and the stitching production is checked. The thread removal process is a process that is carried out to tidy up the remaining threads from the stitches or borders. After the product has passed the scrap disposal stage, the next step is to tidy up the clothes using a steam scrubbing machine. After doing the scrubbing process using a steam scrubbing machine, labeling clothes is an important thing that should not be missed. Preparation is done to compile each finished product. This arrangement also aims to separate several types of clothing that are produced as well as production codes for recording. The last stage of the production process is packing using OPP plastic. OPP plastic is a plastic commonly used by Teresa's SME for packaging. After the packaging process is complete, the product is ready to be distributed to customers in various regions.

Production Historical Data

Table 1. Historical Production Data for April – May 2022

Month	Production Amount	Number of Deffect
April	2888	204
Mei	4405	466
Total	**7293**	**670**

Based on data taken from April 14, 2022 to May 30, 2022, the daily production of suit products with various designs at SME Teresia reaches 7293 units. Meanwhile, the number of defects detected since that time has reached 670 units with various types of defects in the product. This amount is obtained from the results of records made by the sewing operator and the thread waste operator.

Quality Control

Control chart is a graphical tool used to monitor and evaluate whether an activity or process is under statistical quality control or not so that it can solve problems and produce quality improvements. The basic form of a control chart or chart is a graphic demonstration of a quality characteristic that has been measured or calculated from a sample against a sample number or time. This graph contains the center line which is the average value of the quality characteristics related to the controlled conditions (CL). The two horizontal lines are called the upper control line (UCL) and the lower control limit (LCL).

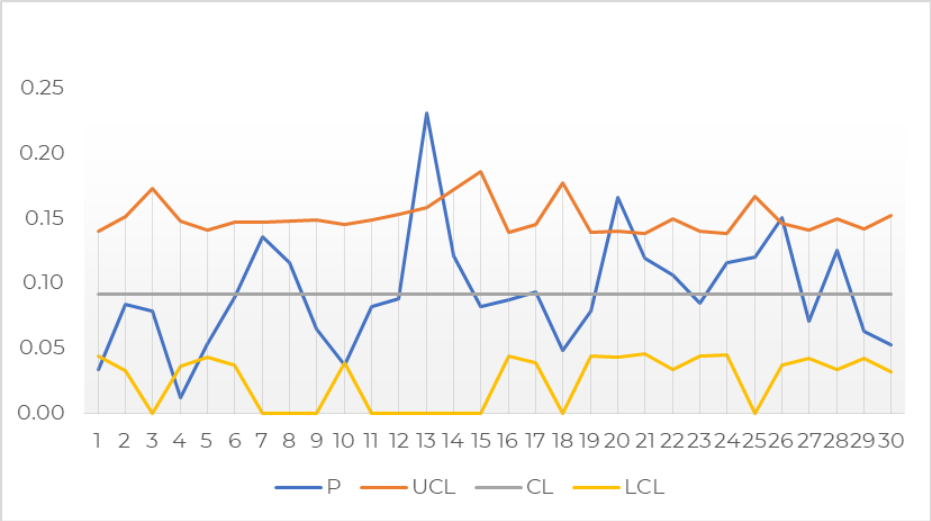

Figure 2. Graph of Attribute Control Map

Based on the graph above, it can be seen that of the 7293 units of clothing produced by Teresia UKM, the control limit has exceeded the control limit. In the graph, it can be seen that only a few periods of the production process did not go out of the middle line or central line. From the results of the calculation of the upper control limit and lower control limit, it can be seen that there are several periods where the P value is out of the control limit, namely in period 4 and period 10, the P value touches the LCL limit. Likewise, in period 13, it is also seen that the P value penetrates the upper control limit or UCL until the value reaches 0.23, the same thing happened in period 20 with a P value of 0.17 and period 26 reaching a value of 0.15. However, in this study, the problem of special causes variation does not need to be carried out further because the next step is to determine the Sigma Level, which means that the overall production process will be analyzed. From the results of the analysis, it can be concluded that there is a root problem that must be solved so that the production system does not have an unnatural number of defects.

Sigma Level

Six sigma is a comprehensive and flexible system for achieving, maintaining, and maximizing business success. Six Sigma is uniquely driven by a strong understanding of customer needs, disciplined use of facts, data, and statistical analysis, and careful attention to managing, improving, and re-embedding business processes. Broadly defined as 3.4 DPMO [3]. The sigma level of the suit production process at Teresia SME is 3.49. It can be judged that the level of production process of Teresa's SME is already at the average level of small and medium industries in Indonesia. However, this must also be monitored considering the level of cost of poor quality or costs caused by poor production quality reaches between 20% to 40% for one product per month.

Pareto Chart

After deciding that there is a problem with Teresia's convection production system, the next step is to identify the largest number of defects and their percentage and cumulative value to facilitate the focus of this quality control research using a tool called the Pareto Chart [5].

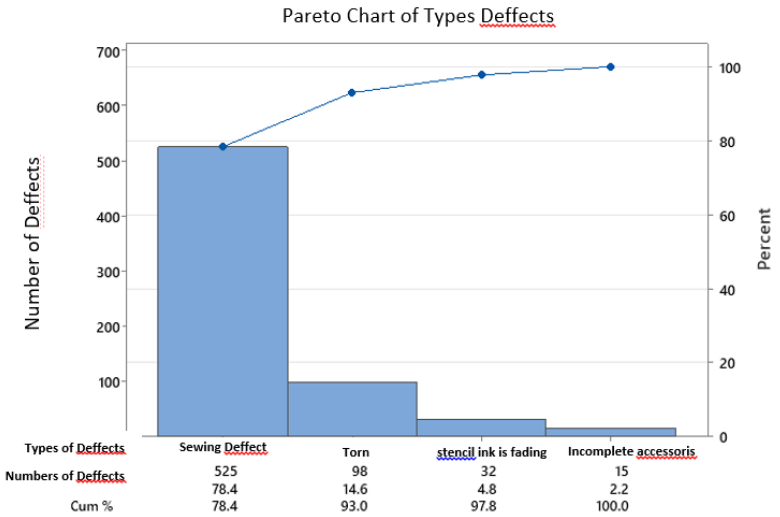

Figure 3. Pareto chart graph

It can be seen that the dominant defect that occurs is a seam defect with a percentage of 78%. These defects come from the sewing process, so to deal with these defects, it is necessary to make improvements to the factors causing the defects in the process to minimize the occurrence of defects. Based on the principles in the Pareto diagram, that is, if the type of defect is handled, then 20% of the problem will be resolved so that the type of sewing defect is a priority that must be corrected first because it is considered to affect customer satisfaction with the product.

Fishbone Diagram

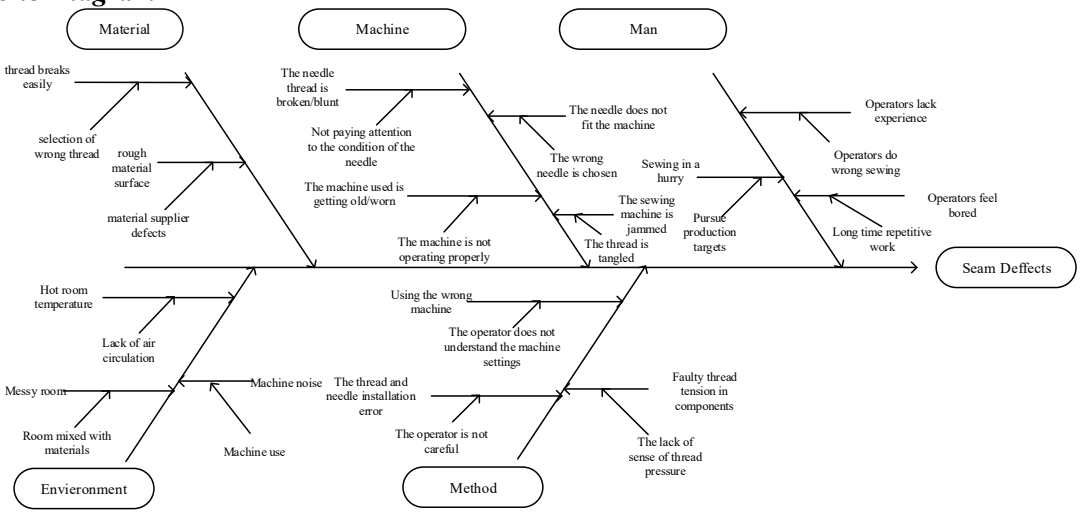

Figure 4. Fishbone Diagram

Fishbone (or Ishikawa) analysis is a structured approach that allows a more detailed analysis to be carried out in finding the causes of problems, discrepancies, and existing gaps [4]. Quality control must have a clear basis of reference when talking about the cause and effect of a production problem. Quality control is not just about improving the production system carried out by the operator, but starting from the receipt of raw materials, storage, management, to the final process. To overcome this, it can be done by formulating all problems from various potential aspects of the occurrence of these problems . From the picture above, it can be seen that there are various types of sewing defects that cause defects

in the product. From the results of interviews with business owners regarding the causes of the disability as follows Man, Machine, Material, Method, Environtment of seam deffects

Failure Mode and Effect Analysis

FMEA is used to analyze which root cause is the most influential from the identification results [2]. By providing a value on severity (severity), Occurrence (possibility of happening), and Detection (detection). The following are the results of determining the severity, occurrence, detection numbers by two experts, namely Mrs. Suryani and a sewing operator. The severity scale of defects caused by the type of potential cause is made based on the type of disturbance due to component damage that the company will receive if the potential cause occurs. The scale of occurrence of the defect waste is obtained from the probability of the frequency of the cause of the failure mechanism that will occur, so that it can produce a failure mode that gives certain consequences. The detection scale built for defect waste is formed by measuring the emergence of potential causes that cause defects in components [8].

Table 3. Recapitulation of RPN Value on FMEA

No	Potential effect of failure	Score RPN
1	The machine used is getting old/worn	240
2	Hot weather makes the room temperature high	196
3	Thread pressure on machine components is too tight or loose	196
4	Machine noise in one room	175
5	Incorrect thread and needle placement	175
6-14	Et cetera	-

Based on the table above, the causes of the problem, potential consequences, and current controls for the failure have been identified. These results are taken from the formulation of the problem taken from the fishbone diagram. Various aspects of the causes of problems in the fishbone diagram can provide different outputs for further analysis.

Analysis of a broken sewing machine

Information gathering serves to determine what machines often malfunction and cause seam defects. In this case, there are 3 sewing machines that have the potential to cause jump stitch defects. The three engines are Typical GC 628, Siruba 747f, and Pegasus Overdeck W500.

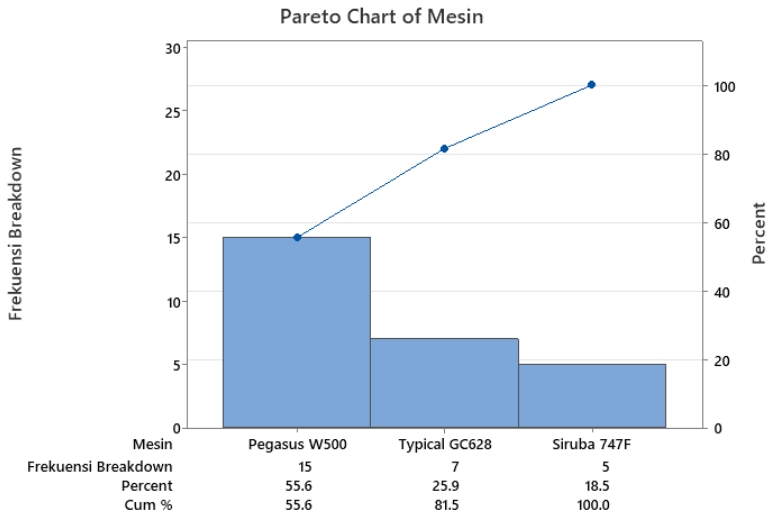

Figure 5. Pareto Diagram of Machine Damage

Machine Failure Description

The following is the workflow of using the Pegasus W500 engine starting from initiation, use, to completion. In the description below, complete information about the system of the Pegasus W500 engine is explained. The results of the information are presented in the form of simple diagrams for easy understanding. After analyzing the workflow on the Overdeck machine, the results obtained are descriptions of the malfunctions in the Overdeck machine from its various components. There are 9 engine components that often malfunction. This is also explained in an in-depth description of the malfunction regarding the cause of the failure while operating the machine.

Analysis of Damage Distribution Using EasyFit 3.0 Software

Mean Time to Failure is the average value of the interval of a fault distribution. The following is the distribution of damage used to calculate the MTTF value [7]. After describing the causes of damage or malfunctions of the Pegasus W500 Overdeck machine, the next step is to determine the distribution of damage from the breakdown day interval data below.

Table 4. Recapitulation of Damage Distribution Using EasyFit3.0 . Software

Distribution	***Kolmogorov Smirnov***	
	Statistik	***Rank***
Normal	0.22808	19
Eksponensial	0.28292	22
Lognormal	0.14479	8
Weibull	0.1503	9

Based on the results of processing using EasyFit software, the smallest result of the Lognormal distribution with a value of 0.14479 is obtained. This value is obtained for the damage interval data on the Pegasus W500 engine from a lognormal distribution. The standard deviation of the lognormal distribution in the experimental analysis of the PegasusW500 engine breakdown time interval is 0.41813. Then based on the distribution in accordance with the characteristics of the time data between the damage parameters of MTTF Lognormal distribution so that the results of the MTTF can be obtained as follows:

$$tmed = e^{0,41813}$$

$$tmed = 1,512$$

$$S = \sqrt{\frac{\Sigma(\ln ti - a)^2}{n-1}}$$

$$= \sqrt{\frac{22.81^2}{13}}$$

$$= 0.79319$$

$$MTTF = tmed(\exp\left(\frac{S^2}{2}\right))$$

$$MTTF = 1,512(\exp\left(\frac{0,79319^2}{2}\right))$$

$$MTTF = 2.07 \approx 2\ Day$$

$$MTTF = 2\ Day \approx 48\ Hour$$

Scheduling Repairs on PegasusW500 . Overdeck Machines

Based on the results of the MTTF calculation, it is found that the lognormal distribution pattern of the engine breakdown time in each component is 48 hours. According to the operating hours of the Pegasus W500 engine, which is 12 hours a day, the occurrence of engine damage or malfunction is every 4 working days. From that time it can be concluded that every 3 working days the machine should be checked or maintained so that there are no problems when used. Therefore, the following is a recommended schedule for checking or maintaining machines for the next 3 months from August 2022 - October 2022 assuming operating hours Monday - Saturday and Sunday can be an option for scheduling maintenance.

Table 5. Scheduling of machine maintenance for August – October 2022

August 2022						
S	S	R	K	J	S	M
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

September 2022						
S	S	R	K	J	S	M
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

October 2022						
S	S	R	K	J	S	M
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	

Based on the table above, it can be concluded that every 3 days the operator must always check the engine components to prevent the engine from happening when it is in use. This preventive maintenance scheduling plan aims to overcome defects in the seams caused by old or worn machines. The following are some things that can be done by operators to prevent damage to the machine, namely:

1. Start cleaning the machine from the lint and thread left behind with a brush or brush. Provide lubricating oil on the throat plate (gear cover) with a lubricant that has good quality.
2. Seeing the condition of the sewing needle when it is felt that the sewing results are not optimal. This is necessary so that the needle does not break or bend when sewing. Because the needle housing can also be scratched inside when the needle used is bent due to use.
3. Replacing bobbins or lifeboats that are rusty or have problems on the sewing machine. This is useful to prevent the thread exit path from being clogged. If you feel that the machine has given signs of a total breakdown, such as the stitching path has stalled, the dynamo is two months old, etc., the operator takes the initiative to bring in a mechanical technician to crosscheck the components.

4. Conclusion

Based on the results of research that has been carried out regarding "Analysis of Quality Control with Statistical Quality Control (SQC) on Teresa Convection SMEs Products" it can be concluded as follows: The value of suit product defects in Teresia SME is still far from stable because there is a proportion of product defect values that are out of the upper and lower control limits. This occurs in period 4 (0.01), period 13 (0.23), and period 20 (0.17). From these data, the Quality Control level was determined using Six Sigma and the average number of suit productions in Teresia SME was 3.49 (3-4 Sigma Level). Based on the results of the description of the opportunity for defects to occur in the suit product, there are 4, namely stitching defects, holes or tears, faded screen printing ink, and incomplete accessories. From this description, it can be determined the focus of the cause of the most defects using a Pareto diagram, namely defects in the seam.

According to the owner of UKM Teresia, the sewing machines they own often experience malfunctions or damage that results in the machine being unable to be used when needed for operations. Therefore, the necessary risk mitigation is preventive maintenance of sewing machines so that it does not happen as mentioned above. To carry out preventive maintenance, further analysis is needed regarding the data when the damage occurred. The time data will then be calculated the time interval for the occurrence of damage using MTTF. The MTTF obtained is 2 days (48 hours) this time will then be a reference for carrying out preventive maintenance. So the recommendation given is that every 3 days in 7 days periodic checks are carried out and do things such as cleaning components with a brush, replacing components that are easy to replace, and calling technicians before total damage occurs.

5. Acknowledgements

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