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Analysis of Shoe Upper Product Defect with the Seven Tools and Failure Mode and Effect Analysis (FMEA) Methods in PT. XYZ

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ABSTRACT

PT XYZ is a company engaged in the manufacturing industry with the production of shoe uppers. In the shoe upper production process, defects such as broken pulltab, mudguard crack, tilted backtab, and false collbar are still found which affect quality. The purpose of this study is to determine the level of defects that most often occur so that it can provide suggestions for improvement to reduce the defects of upper shoe products. The methods used are Seven Tools and Failure Mode and Effect Analysis (FMEA). Seven Tools include check sheets, statistics, histograms, pareto charts, pareto diagrams, scatter diagrams, control diagrams, and fishbone diagrams. Then proceed with FMEA analysis to get suggestions for corrective action. Based on the results of research on Seven Tools, it is known that the most dominant defect in shoe uppers is broken pulltab (38.4%), then mudguard crack (30.64%), tilted backtab (16.49%) and false collbar (14.47%). Based on the results of Failure Mode and Effect Analysis (FMEA) research, it is known that the cause of the highest problem at RPN 288 is unbalanced thread setting. The proposed improvement suggestion is to balance the upper thread tension and lower thread tension of the sewing machine.

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1. INTRODUCTION

Evolution in the industrial world today, has led to increased competition in the industrial world itself. Basically, the development of the industrial world as one of the supporting factors for the success of development in Indonesia, with the increasingly intense competition faced by a company must be more responsive to the competition. Companies must be able to take the right steps and prepare the right strategies, concepts and techniques in order to win the competition, one of which is by improving the quality of a product. With quality control and the use of statistical methods, it is expected to have a very significant impact on the quality of the final product that can meet company standards and can also be a cost efficiency for the company. Because every company will try as much as possible to produce products that are acceptable and meet consumer desires (Andespa, 2020). PT XYZ is one of the companies engaged in manufacturing with the production of shoe uppers. As a quality-oriented company quality-oriented company, PT XYZ realizes the importance of quality, quality control to maintain consumer confidence consumer confidence in the products produced. Therefore, in its production process, PT XYZ always strives to provide the best products for its customers. Always tries to provide the best products for business partners both in terms of price and quality. During the production process there are still many defects including broken pulltab, crack mudguard, tilted backtab and false collbar. And of all the defects that have been observed, it is known that defects in the the upper shoe production process has a total defects amounted to 7%.

Based on the description of the problems above, the purpose of this study is to determine the level of defects that occur most frequently. In addition, this study also aims to provide proposed actions to improve welding quality. It is hoped that the results of this study can provide input and input and contribution to the company in analyzing the quality of the final product produced and determining production quality control policies that can produce quality products in accordance with the specified standards. Therefore, in accordance with the discussion above, the researcher applies the Seven Tools method to determine the causes of product defects to occur and FMEA analysis to provide suggestions for improvements to the quality of shoe upper production quality control at PT XYZ.

2. LITERATURE REVIEW

This chapter discusses the theories that support and play a crucial role in supporting the research implementation. These include the thories on Quality, Quality Control, Seven Tools, and Failure Mode and Effect Analysis (FMEA). These theories will serve as the researcher's guide in conducting the study. Quality as a keyword in industrial competition, can be strategically defined as everything that meets the wants or needs of customers (Lafeniya & Suseno, 2023). Quality is a benchmark to assess whether a product or service can meet the needs of consumers who have their own standards. Quality is one of the standards by which companies can compete fiercely in the world of manufacturing and service industries. It can be concluded that quality is a measure used by potential consumers or consumers as a tool for using products or services. Consumers will review the quality of a product or service when it meets their needs, wants and expectations (Mulia, 2022).

Quality is the most basic factor for customer satisfaction. When a company produces a product, of course, it must pay attention to quality in order to achieve the company's desire to satisfy customers. To produce quality products from raw materials, the production process to the actual product, product quality is one of the main objectives of the company. In today's development, companies must always have innovations to improve their efficiency, effectiveness, and performance in order to compete with others (Andespa, 2020). Therefore, understanding and improving this quality is a fundamental factor for business success, growth, and increased competitiveness. Quality control is one of the activities or activities that is very important to do so that the company can maintain the quality of the products or services produced and continue to make improvements to reduce the occurrence of product defects (Sari & Puspita, 2018). Quality control is a system that verifies and maintains or maintains the required level or degree of quality of products and processes through proper planning, use of correct equipment, continuous inspection and corrective action when needed. Therefore, quality control is more than just inspection activities or determining the quality of the product whether it is accepted or rejected (Manik, 2020). Quality control begins with the process of inputting raw materials or information by marketers and buyers, until the raw materials are processed in the factory (conversion stage) and then sent to consumers (Kuswardani et al., 2020). Quality control requires understanding and needs to be implemented by the designer, inspection. Research by Mislan and Purba (2020), showed that the SQC method through the application of seven tools and utilization of FMEA to reduce the percentage of product defects.

3. RESEARCH METHOD

In this research, the Seven Tools method and

Failure Mode and Effect Analysis are used. The following flow to solve this problem can be seen in Figure 1.

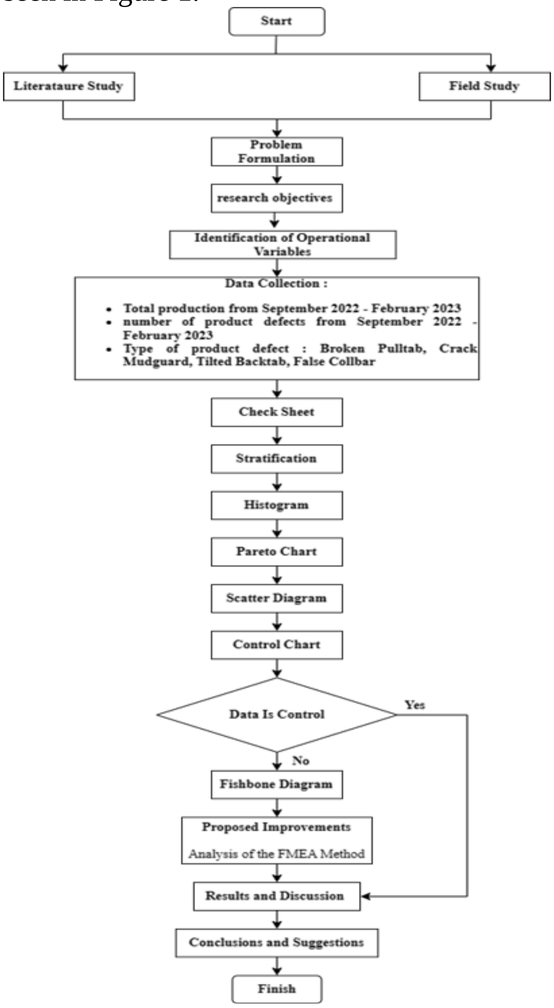

Figure 1. Research stage

Based on the Figure 1, the research stages are a series of steps that must be taken in a research process to achieve predetermined goals. The description of the sequence of solving an event above is to conduct a survey of existing problems to determine the formulation of problems and research objectives, then identify the dependent variable (Quality Defects of shoe upper products at PT. XYZ) and the independent variable (types of shoe upper defects). Then collect research data including primary data from interviews with the QC division and secondary data in the form of shoe upper production data. Next, process the data with the Seven Tools method (check sheet, stratification, histogram, pareto diagram, scatter diagram. control chart and cause and effect diagram), then make an improvement suggestion with FMEA analysis based on the calculation of the RPN value of the multiplication of Severity (S), Occurance (O), and Detection (D). These stages form a systematic framework and help researchers to organize and direct the research process clearly and purposefully.

4. RESULT AND DISCUSSION

In the calculation using the Seven Tools method and improvement recommendations using the FMEA method with the following results:

4.1 Check sheet

Check sheet is a tool used to record the results of data collection for a specific purpose and to present data in a communicative form so that it can be converted into information. The results of data collection on types of defects through check sheets can be seen in Table 1.

Table 1. Check sheet of defect data

Month	Defects Type				Total
	False Collbar	Crack Mudguard	Broken Pulltab	Tilted Backtab	
Sep-2022	20	55	65	28	168
Okt-2022	31	47	68	37	183
Nov-2022	18	40	52	10	120
Des-2022	45	55	85	35	220
Jan-2023	14	52	45	25	136
Feb-2023	8	39	46	20	113
Total	136	288	361	155	940

(Source: production data, 2023)

In Table 1, The check sheet data used is the company's internal data or production data of PT XYZ for the last 6 months, where in the check sheet table can record the types of defects that are often found in shoe upper products, such as false collbar, crack mudguard, broken pulltab and tilted backtab. By recording the number of occurrences of each type of defect, it can identify the most common types of defects and focus on appropriate improvements.

Stratification

Startification is the stage for grouping data in groups that have the same characteristics. The results of the startification according to the check sheet are shown in Table 2.

Table 2. Stratification

Month	Total Production	Defects Type				Total
		False Collbar	Crack Mudguard	Broken Pulltab	Tilted Backtab	
Sep-2022	2400	20	55	65	28	168
Okt-2022	2600	31	47	68	37	183
Nov-2022	1700	18	40	52	10	120
Des-2022	3000	45	55	85	35	220
Jan-2023	1800	14	52	45	25	136
Feb-2023	1600	8	39	46	20	113
Total	13100	136	288	361	155	940

(Source: production data, 2023)

Stratification of the data used is the company's internal data or production data of PT XYZ for the last 6 months, where in the stratification table can separate data into subgroups based on certain variables such as, total production in each month, types of defects that are often found, and total defects each month. By using stratification, it can take targeted corrective actions and improve the overall quality of the product or process.

Histogram

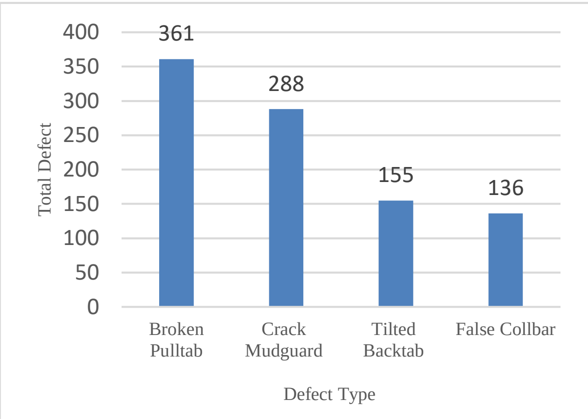

Figure 2. Histogram
(Source: processed data, 2023)

Based on the histogram figure, it can be seen that the interval order of each type of defect that occurs the most is known to be 361 unit of broken pulltab defects, then crack mudguard with a total defect of 288 unit, then tilted backtab defect with a total defect of 155 unit and false collbar defects with a total defect of 136 unit.

Pareto Chart

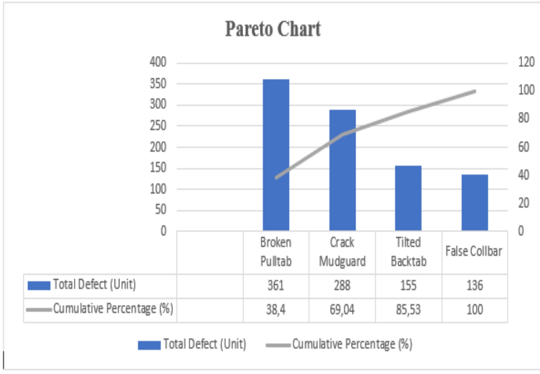

Figure 3. Pareto chart
(Source: processed data, 2023)

Based on the Pareto diagram, it can be seen that the most dominant type of defect seen from the cumulative percentage is broken pulltab with a percentage of (38.4%), followed by crack mudguard with a percentage of (30.64%), then tilted backtab with a percentage of (16.49%), and false collbar with a percentage of (14.47%).

Scatter Diagram

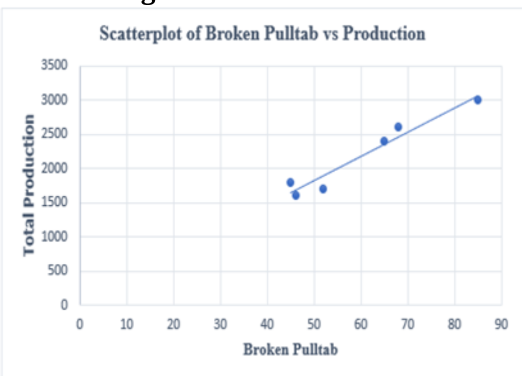

Figure 4. Scatterplot of broken pulltab vs total production
(Source: processed data, 2023)

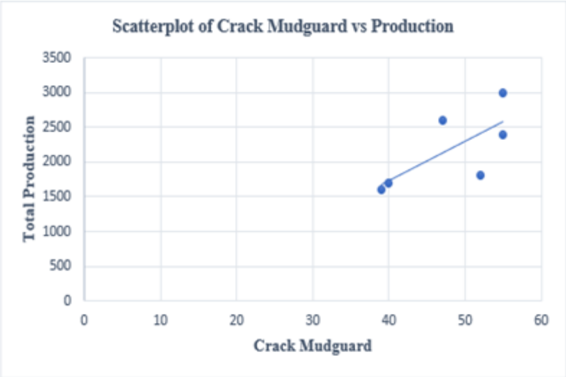

Figure 5. Scatterplot of crack mudguard vs total production
(Source: processed data, 2023)

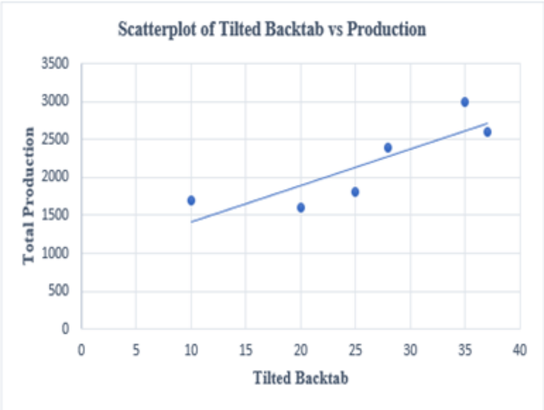

Figure 6. Scatterplot of tilted backtab vs total production
(Source: processed data, 2023)

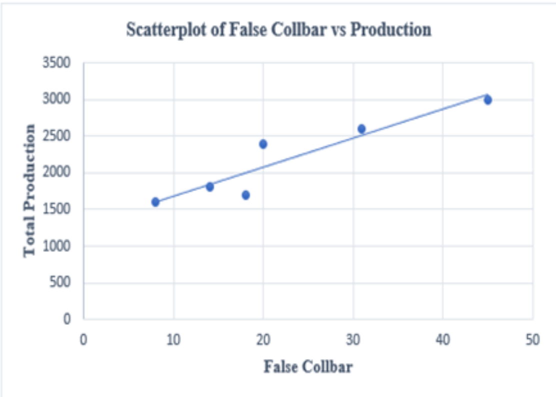

Figure 7. Scatterplot of false collbar vs total production
(Source: processed data, 2023)

Based on the scatter diagram above, the four types of defects, namely broken pulltab, crack mudguard, tilted backtab and false collbar on shoe upper production show the results that of the four types of defects where the increasing variable X is followed by an increase in variable Y, meaning that when there is an increase in production, there is an increase in the number of defects as well and vice versa.

Control Chart

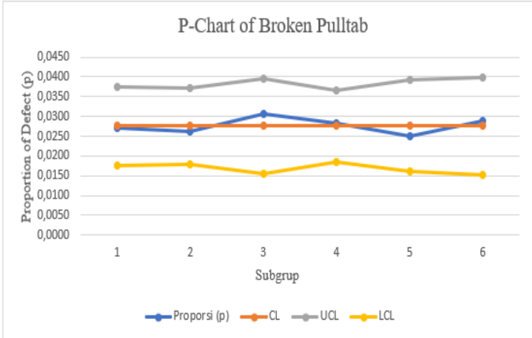

Figure 8. P-chart broken pulltab
(Source : processed data, 2023)

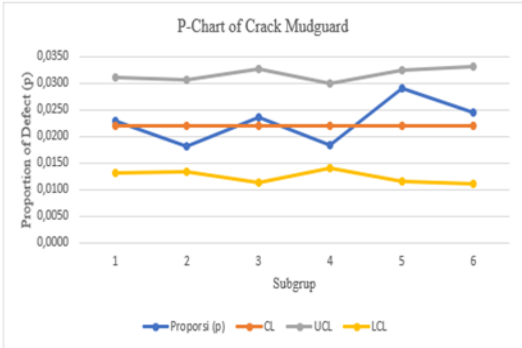

Figure 9. P-chart carck mudguard
(Source: processed data, 2023)

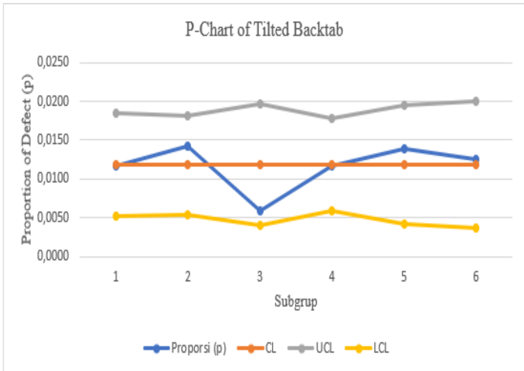

Figure 10. P-chart tilted backtab
(Source: processed data, 2023)

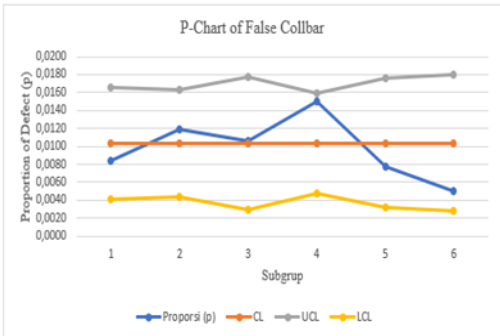

Figure 11. P-chart false collbar
(Source: processed data, 2023)

From the data processing that has been carried out, the data is still within the upper control limit and lower control limit. Since there is no data out of the control limits, it can be concluded that the percentage of defective products in shoe upper products is within the control limits.

Cause and Effect

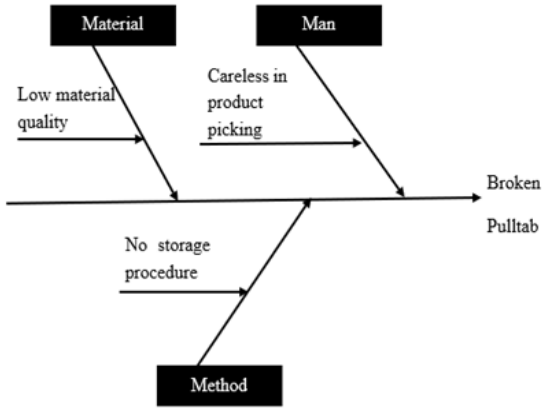

Figure 12. Cause and effect diagram broken pulltab (Source: processed data, 2023)

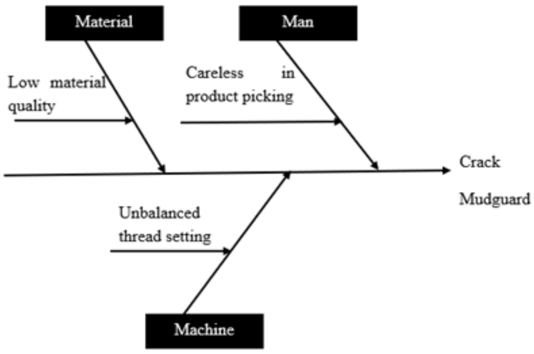

Figure13. Cause and effect diagram crack mudguard (Source: processed data, 2023)

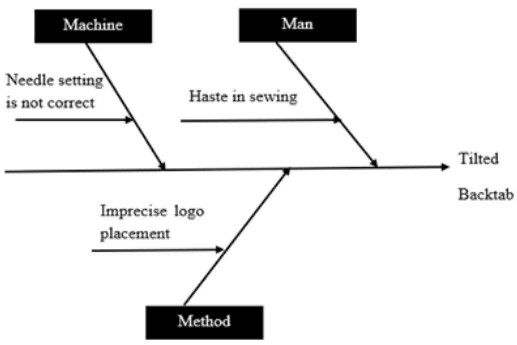

Figure 14. Cause and effect diagram tilted backtab (Source: processed data, 2023)

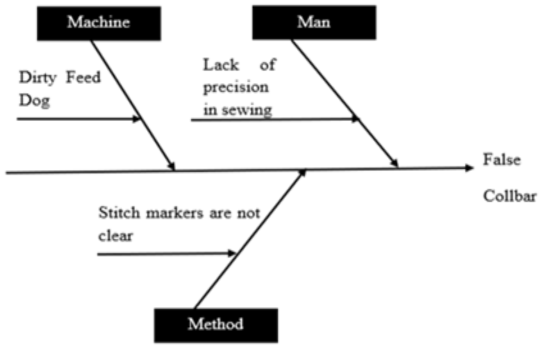

Figure15. Cause and effect diagram false collbar (Source: processed data, 2023)

From the Figure 12-15 the cause and effect diagram above is the root cause of each type of defect in the shoe upper products studied, namely there are broken pulltab, crack mudguard, tilted backtab and false collbar. Where the root cause data of the cause and effect diagram is obtained through several sources, namely, first by making direct observations at the company or in the production process by observing the process directly, and identifying the factors that are the root causes of defects. Second, it is obtained from operational data such as production records, inspection reports, and product failure data that provide information about the problems that occur. The third is obtained from qualitative data collection such as interviews with superiors or employees, to gain their insights and perspectives and quantitative data through measurement and statistical analysis provides objective information about variables that affect quality. Based on the cause and effect diagram, it can be seen the causes of defects in each factor. For **broken pulltab**, the cause of the problem is from the method because there is no storage procedure, from the human aspect because of carelessness in picking up the product, and from the material aspect because of low material quality. For **crack mudguard**, the causes of the problem are from materials due to low material quality, from humans due to carelessness in picking the product, and from machines due to unbalanced thread settings. For **tilted backtab**, the causes are human due to haste in sewing, method due to imprecise logo placement, and machine due to incorrect needle settings. For false collbar, the cause of the problem is human due to lack of care in sewing, method-wise due to unclear stitch markers, and machine-wise due to dirty dog feed.

Failure Mode Effect Analysis (FMEA)

Failure Mode and Effect Analysis is a reliability analysis method intended to identify failures, which have the consequence of affecting the functioning of the system within the boundaries of a given application, thus allowing priorities for action to be set (Putri, 2021). Traditionally, FMEA is used to conduct risk analysis through the Risk Priority Number (RPN), which is derived from a combination of Occurrence (O), Severity (S) and Detection (D).

Table 3. FMEA frozen edamame

Potential Failure Mode	Potential Effect of Failure	**S**	Potential Cause	**O**	Current Control	**D**	**RPN**
Broken Pulltab	It It will cause dysfunction in the pulltab so that the user will experience difficulty when wearing shoes.	8	Low material quality.	5	Selecting materials before use	3	120
			Careless in taking the product.	5	Supervise the process of taking the product in accordance with the procedure	7	280
			There is no save procedure.	4	Create Standard Operating Procedures for storage	5	160
Crack Mudguard	It will reduce the strength of the front part of the upper when combined with the outsole so that the front part of the upper is easily detached.	8	Low material quality.	5	Selecting materials before use	3	120
			Careless in taking the product.	5	Conducting briefings on tailors	2	80
			Unbalanced thread settings.	6	Balance the top thread tension and bottom thread tension of the sewing machine	6	288
Tilted Backtab	It. It will reduce the aesthetic value of the shoe because the visual appearance is not good.	3	Incorrect needle setting.	6	Replace the sewing needle and thread the needle according to the procedure	4	72
			Haste in sewing.	5	Remind the tailor to sew according to the procedure	4	60
			Imprecise logo placement.	5	Placing the product logo according to the procedure	5	75
False Collbar	It will cause the stitching to not be strong so that the shoe part will peel off easily.	7	Not careful in sewing.	5	Remind the tailor to sew according to the procedure	2	70
			Dirty Dog Feed	6	Clean feed dog and apply lubricating oil.	4	168
			Stitch markers are not clear	4	Thicken the suture marker according to the procedure	5	140

(Source: focus group discussion, 2023)

Based on the results of the calculation of the RPN (Risk Priority Number) value, it can be seen that the process failures that cause defects, the causes of disability (Potential causes) are then sorted from the highest to the lowest RPN value and then given recommendations for improving each cause. The order of improvement recommendations based on RPN can be seen in Table 4.

Table 4. Recommendations for improvement based on RPN ranking

Priority	Potential Failure Mode	Potential Cause	RPN	Recommendation
1	Crack Mudguard	Unbalanced thread settings	288	Balance the top thread tension and bottom thread tension of the sewing machine
2	Broken Pulltab	Careless in taking the product	280	Supervise the process of taking the product in accordance with the procedure
3	False Collbar	Dirty Dog Feed	168	Clean feed dog and apply lubricating oil.

(Source: focus group discussion, 2023)

Based on the results of the RPN calculation for FMEA shoe upper, several risks are obtained that have the highest priority level for making improvements to minimize the possibility of errors. The calculation of the highest RPN value is 288 from the type of defect Mudguard torn with a potential case of unbalanced thread settings with proposed recommendations for improvement, namely balancing the upper thread tension and lower thread tension of the sewing machine, the second order is the RPN value of 280 from the type of defect Pulltab Broken with a potential case of carelessness in product retrieval with proposed recommendations for improvement, namely supervising the product retrieval process in accordance with procedures, and for the third order, the RPN value of 168 from the type of defect Collbar Torn with a potential case of dirty briber teeth with proposed recommendations for improvement, namely cleaning the briber teeth and providing lubricating oil. After taking action for 3 priority ratings (Crack Mudguard, Broken Pulltab, False Collbar), where the number of defects has decreased and is under control within the defect standard limit set by the company of 5%. Previously, of all the defects that have been observed, it is known that defects in the edamame production process production process had a total defect of 7%, which means it was outside of the predetermined standard limit of 5%. The relationship between Seven Tools and FMEA lies in the way they complement each other in solving edamame quality control problems. SQC is used to control quality during the edamame production process, while FMEA is used to identify and address potential failures in the design or production process of edamame. Here is a further explanation of the relationship of each tool in edamame quality control problem solving:

Seven Tools:
(1) Data collection, in the Seven Tools method, data related to shoe upper quality such as size, roductin quantity, etc. are collected regularly during the production process. (2) Statistical Analysis, the collected data is analyzed using statistical techniques such as startification, check sheets, histograms, pareto, scatter diagrams or map diagrams to identify significant patterns, deviations or changes in shoe upper quality. (3) Action Taking, If the statistical analysis indicates any deviation from the set quality standards, corrective measures such as machine adjustments, process parameter changes, or operator training can be taken to control edamame quality.

FMEA
(1) Identify Potential Failures, in the FMEA method, the team comes together to identify various failure modes that may occur during the shoe upper production, for example, the number of broken pulltab, crack mudguard, tilted backtab and false collbar. (2) Effect and Risk Evaluation, once the failure modes are identified, analyzes the potential effects of each of these failures on edamame quality and the impact on customers or consumers. Risk levels are assigned based on a combination of failure severity, occurrence and detection. (3) Corrective Action, after analyzing the risk of failure, proposes and implements appropriate corrective actions to reduce the risk of the failure. Seven Tools and FMEA complement each other in optimizing quality control of edamame products. SQC helps in controlling quality during the production process, while FMEA helps in identifying and addressing potential failures through risk analysis and appropriate corrective action.

5. CONCLUSION

Based on the results of data processing with seven tools, it can be seen that the dominant defect in the quality of shoe uppers is Broken Pulltab with a percentage of 38.4%, followed by Torn Mudguard with a percentage of 30.64%, then Backtab Tilted with a percentage of 16.49%, and Wrong Collbar with a percentage of 14.47%. The factors causing the defect of Broken Pulltab are in terms of low quality materials, in terms of human carelessness in taking products, and in terms of methods there is no storage procedure. Based on the results of the RPN calculation for FMEA shoe upper, several risks are obtained that have the highest priority level for making improvements to minimize the possibility of errors. The calculation of the highest RPN value is 288 of the Mudguard Tear defect type with the cause of unbalanced thread settings. The proposed improvement recommendation for this problem is to balance the upper thread tension and lower thread tension of the sewing machine.

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