

Production Process Analysis to Reduce Defective Products through the Application of Pareto Diagram and The Eight Disciplines Problem Solving Method

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ABSTRACT

Quality control involves efforts to uphold and enhance product quality in order to align with the specifications established by customers. Employing a combination of the Pareto diagram and the 8D (Eight Disciplines Problem Solving) method represents a robust approach to systematic problem-solving, particularly in manufacturing and quality settings. These two methods can be used together to identify the root causes of problems and then implement effective solutions. This study aims to analyze quality improvement efforts in the production of fiber drum paper as an eco-friendly packaging, focusing on dent defects in the upper body area of the drum, which were found in the crushing and curling process at PT. X. The findings indicated that there were still several defects in the current production process, with the most significant defects occurring in fiber drum paper products. where the dent defect in the upper body area of the drum reached 2%. After improvements were made using the Pareto diagram, Fishbone diagram and the eight disciplines problem-solving method, the dent defect in the upper body area of the drum was successfully reduced to 0.8%, meeting the set improvement targets.

INTRODUCTION

In the industries product quality is one of the key factors determining a company's success [1]. Defective products not only result in financial losses but can also damage a company's reputation in views of customers. Every company must improve the quality of its existing products and services [2], companies need to make maximum efforts to reduce the defect rate in the production process [3] Optimizing the production process is one way to achieve this. If these two shortcomings are not addressed, the industry may miss opportunities for improvement and innovation, potentially falling behind competitors in terms of quality, cost efficiency, and customer satisfaction [4], [5]

Production process optimization involves reviewing and improving steps in the process to enhance efficiency and effectiveness [6] The Pareto Diagram is an effective tool that can be used in quality control [7], It is used to analyze and identify the main issues causing defective products [7], [8], [9], [10], [11]. By effectively using Pareto analysis, it can enhance the performance of key operational processes, resulting in higher resource utilization, less variance, and consistent process output quality [10], [12]. On the other hand, the Eight Disciplines Problem Solving (8D) method is a systematic approach used to identify the root causes of problems and implement effective solutions. This

method consists of eight steps, including team formation, problem description, root cause analysis, corrective actions, and prevention to ensure the problem does not re-occured [13], [14]. The use of the 8D method in conjunction with the Pareto Diagram allows companies to conduct in-depth analysis and implement continuous improvements.

In this study, the cardboard packaging sector was chosen because the products produced in this sector are used for packaging food items as well as other products. The 8D method and other quality tools are widely known and frequently used in the automotive industry. However, the application of the 8D method in other industries is still limited.

PT. X is a manufacturing industry company located in the pasuruan district engaged in plastic injection and cardboard, based on the problems faced by PT. X is the high product defect, especially in fiber drum paper products that occur repeatedly, causing the company to need to handle seriously and further, based on these conditions, the Implementation of 8D based on Pareto-Ishikawa Diagram for Fiber Drum Paper Product Improvement at PT. X is very suitable to be applied. The concept designed in this research will later be applied to the company. This research aims to contribute to the industry and literature by using the 8D method effectively in the production process outside the automotive sector.

MATERIAL AND METHODS

The problem in this study occurs in the fiber drum paper production process at PT. X. The approach used is the 8D method, with problem identification utilizing a Pareto diagram. Data collection methods include observation, interviews, and literature review. This method was chosen to ensure that problem-solving can be presented in a thorough and detailed manner, allowing for more optimal research outcomes [15]. The 8D method is one of the improvement steps used in the following sequence:

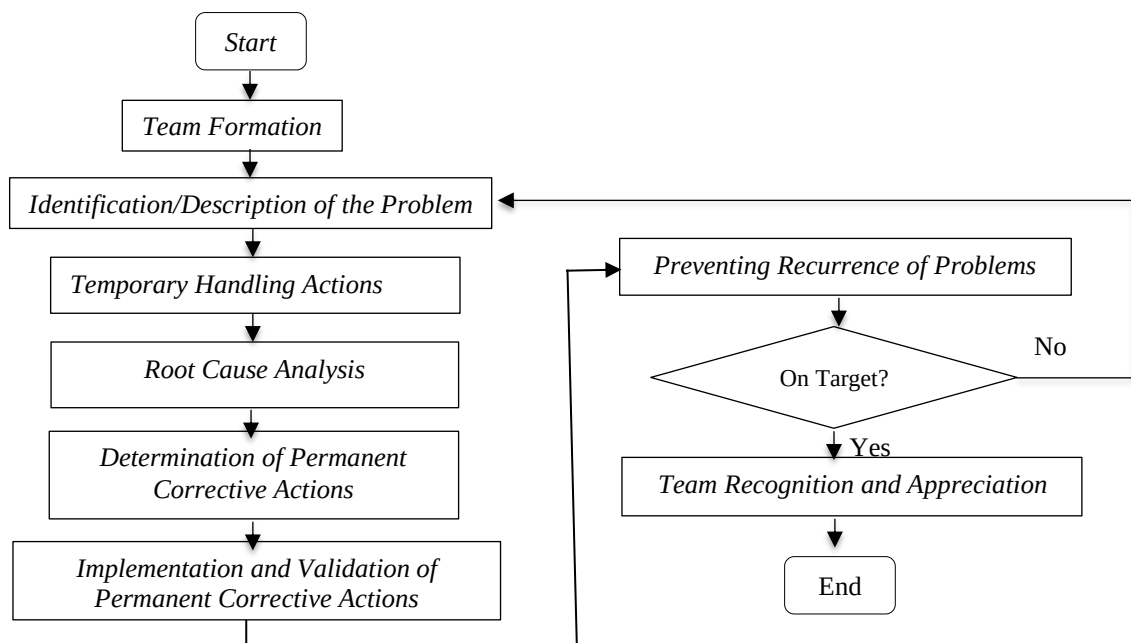


Figure 1. Research Methods

RESULTS AND DISCUSSIONS

1. Team Formation

The formed team consists of 3 managers, 1 production staff, 1 mechanical staff, and 1 QA staff, with the roles and responsibilities of each staff member as follows:

Table 1. Cross-Functional Team

Team	Dept.	Job description
Leader (QC Manager)	Quality	Managing the team, monitoring, and empowering members
Member 1 (Prod'n Staff)	Prod'n	Conducting initial handling
Anggota 2 (QA Staff)	Quality	Leading investigations and participating in problem resolution activities
Member 3 (Maintenance Staff)	MNTC	Leading investigation and involve in the problem resolution activity
Member 4 (Prod'n Manager)	Prod'n	Providing advice to the organization regarding problem resolution activities
Member 5 (QA Manager)	Quality	Being responsible for problem investigations and representing customers (both internal and external)

Source: Data processing

2. Identification/Description of the Problem

The total number of customer complaints from 2021 to 2023 is 7 (one of which is a recurring complaint). The problem occurrence point is defined as "dented products during the assembly process." The defect trend data with the pareto diagram also shows that the highest defect is dented products, necessitating a comprehensive evaluation of the issue. The evaluation should include details such as the time and place of the problem occurrence, a specific description of the failure mode, failure rate, quantity produced, number of non-conforming products, and other relevant information. Based on the evaluation results, the data obtained is as follows: [15], [16], [17], [18], [19]:

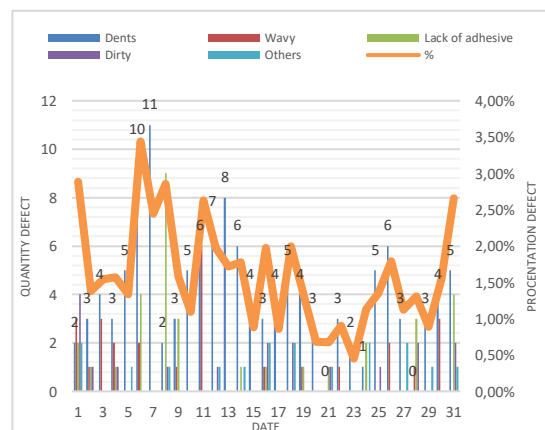


Figure 2. Daily Quality Trend May 2024

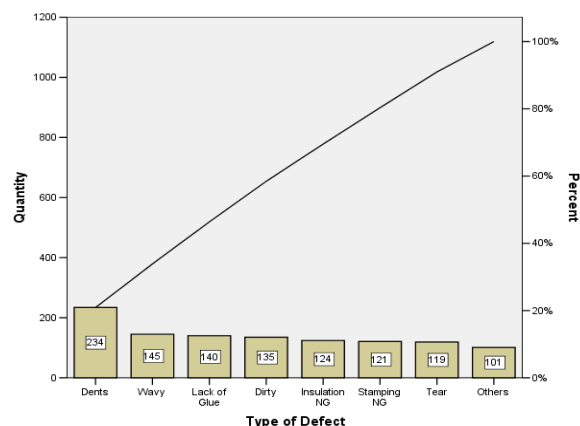


Figure 3. Top Defective May-July 2024

3. *Temporary Handling Actions*

To effectively isolate the problem, actions were taken to block stock to prevent it from being sent to customers, to place warning signs, and to inform employees about the ongoing issues; check stock storage, and sort stock in the customer warehouse. This can be detailed as follows:

Table 2. Corrective Actions to Prevent Damage

Temporary Preventive Actions				
SPECIAL PREVENTIVE ACTIONS (explain): Quality warnings were installed on the production floor to ensure that all parts understand and are aware of customer quality issues.				
Temporary actions to address the problem and "fix" it until permanent corrective actions are available (validating that the actions taken are successful)				
Product Quality Identity	Yes	x	No	0 pcs
Materials In Process (Quantity)	Good	NA	Bad	0 pcs
Materials In Warehouse (Quantity)	Good	NA	Bad	0 pcs
In Transit (Quantity)	Good	NA	Bad	0 pcs
Customer Warehouse (Quantity)	Good	NA	Bad	0 pcs
Certification Mark on Parts/Boxes	Yes	x	No	0 pcs
Estimated Material Date:		13	9	2024
		mm	dd	yyy
Marking Method	Red Mark (has been inspected)			

Source: Data processing

4. *Root Cause Analysis*

Root Cause Analysis (RCA) is a structured process for finding the underlying causes of a problem or incident, with the aim of preventing the same issue from occurring in the future. In this study, we used the Ishikawa diagram to help analyze the root causes of the problem. The Ishikawa diagram, also known as the Fishbone Diagram or Cause and Effect Diagram, is a visual tool used to systematically identify and analyze potential causes of a specific problem or effect. Developed by Kaoru Ishikawa, this diagram helps teams organize potential causes into categories, making it easier to identify the root cause. [20], [21].

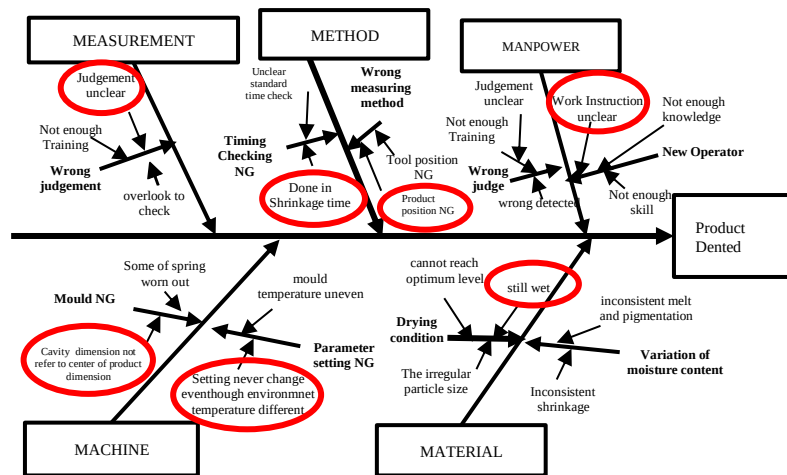


Figure 4. Fishbone Diagram

By using the Ishikawa diagram, the root causes were identified in the aspects of people, methods, measurements, and machines.

5. Determination of Permanent Corrective Actions

Corrective actions must be clearly linked to each specific root cause analysis, both for the occurrence of failures and leaks. The goal of the fifth discipline in the 8D methodology is to select the most effective permanent corrective actions to eliminate the root causes of the problem and to find the best permanent solutions for the leak locations.

Table 3. Determination of Permanent Corrective Actions

Determination of Permanent Corrective Actions			
To minimize dented products, our team has identified the following improvement items:	PIC	Due Date	Status
Corrective Actions for Root Causes of Incidents in the Process			
1. Conduct daily sample inspections to ensure the performance of the curling and pressing machines	Team 1,2 and 3	Sep-24	Closed
2. Shorten the curling and pressing at the ends of the paper drum to enhance the strength of the drum paper			
Corrective Actions to Address Root Causes of Product Inspection Failures Reaching Customers			
1. To validate the effectiveness of the applied corrective actions, the next production lot orders will be 100% inspected.	Team 2	Sep-24	Closed
2. Review the curling length against inspection standards.			

Source: Data processing

6. Implementation and Validation of Permanent Corrective Actions

The goal of the sixth discipline in the 8D methodology is to assess the effectiveness of the corrective actions that have been implemented and to ensure that no negative side

effects have arisen. It is crucial to accurately evaluate the effectiveness of each corrective action. There must be clear evidence that the failure mode or defect does not reoccur, which is confirmed with 100% confidence, and that the quality of the production process has improved as a result.

Table 4. Implementation and Validation of Permanent Corrective Actions

Implementation and Validation of Permanent Corrective Actions		
Permanent Corrective Actions	PIC	Due Date
To validate the effectiveness of the applied corrective actions, the next production lot orders will be 100% inspected	Team 2	Nov-24
Conduct daily sample inspections to ensure the performance of the curling and pressing machines	Team 1, 2	Nov-24
Shorten the curling and pressing at the ends of the paper drum to enhance the strength of the drum paper.	Team 3	Nov-24
Review the curling length against inspection standards	Team 2	Nov-24

Source: Data processing

7. Preventing Recurrence of Problems

In this step, preventive actions are implemented to avoid similar issues in the process and production of other products. Additionally, related systems are updated, including policies, practices, and work procedures, to prevent the recurrence of this problem and other similar issues (e.g., control plans, work instructions, standard operating procedures, and inspection sheets)

Table 5. Prevention of Recurrence of Problems

Prevention of Recurrence of Problems			
Preventing Recurrence of Problems	PIC	Due Date	Status
Training for all relevant departments with direct interaction will be conducted	Leader	Nov-24	Open
Implementation of corrective actions for similar machines	Team 4 and 5	Nov-24	Open
Sample inspections of the curling and pressing machines by QC every 2 hours	Team 2	Nov-24	Open
Review all affected documents/systems			
Document	PIC	Completion date	Doc. No
Validasi tindakan korektif	Team 5	Nov 24	
Maintenance routine	Team 3	Nov 24	
Training	Leader	Nov 24	
Update corrective actions.	Team 2	Nov 24	
Update Control Plan	Team 2	Nov 24	
Update SOP and WI	Team 2	Nov 24	
Others (Specify)			

Source: Data processing

8. Team Recognition and Appreciation

A final meeting with the 8D team was held to review and evaluate the steps taken from stage D1 to stage D8. The conclusion involved reaching an agreement with all parties

involved. All 8D activities related to this issue have been completed without any action items pending or "in progress." We acknowledge the contributions of each team member.

Table 6. Team Recognition and Appreciation

Team Recognition and Appreciation			
Lessons Learned	PIC	Due Date	Status
The capability of the curling machine, which correlates with the length of the curling and pressing results, affects the strength of the paper	Team 2	Nov 24	Open
Schedule meetings to review the implementation of each corrective action, and then close the 8D report.	Team 2 and 5	Nov 24	Open
Management review and approval			
Yes/ No	Leader/Department	PIC	Date
Yes	Quality Manager	Quality Manager	Nov 24
Yes	Director	Director	Nov 24

Sumber: Olah data

To ensure that the results of this research activity are able to overcome the existing problems, a trial implementation of the proposed process improvement will be carried out. This trial ensures that process activities, machines, people, materials have no adjustments or changes in conditions between before and after implementation. This trial is carried out for 1 day, later these results will be compared with the results of the previous process or the process in accordance with the conditions in the company.

Based on the results of the initial identification with Pareto, the main cause of defects is the type of dent. In the implementation results after implementing production process improvements and monitoring the process after improvement for 1 day, the data obtained for dented products decreased from 0.02 or 2% to 0.008 or 0.8%. Dented products are also a recurring customer complaint so that the daily defective trend must be monitored continuously to ensure that the improvements made are effective.

Table 7. Dents Defect Before implementation

Date Detected (Day/Month/Year)	: 11/11/2024
Detected Place	: Line Prod'n Customer
Problem Identification	: Product Dented
Impact to Customer	: Identification Issue
Customer Part No./Lot No.	: AP*****NAR
Input Quantity	: N = 10.000 pcs
Sampling Quantity	: n = 500 pcs
Number of Defects	: r = 10 pcs
Percentage of Defects	: P = 0.02 atau 2%

Table 8. Dents Defect After implementation

Date Detected (Day/Month/Year)	: 11/12/2024
Detected Place	: Line Prod'n Customer
Problem Identification	: Product Dented

Impact to Customer	: Identification Issue
Customer Part No./Lot No.	: AP*****NAR
Input Quantity	: N = 10.000 pcs
Sampling Quantity	: n = 500 pcs
Number of Defects	: r = 4 pcs
Percentage of Defects	: P = 0.008 atau 0.8%

CONCLUSION

After implementing production process improvements and monitoring the process for a week, data showed that dented products decreased from 2% to 0.8%. Dented products had also been a recurring customer complaint, so the daily defect trend must be continuously monitored to ensure that the improvements made are effective.

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