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Quality Improvement of Capacitors through Fishbone and Pareto Techniques

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Abstract*: In the present scenario there are various methods are available to improve and control the product quality of any organization but it is necessary to continue monitoring and measuring the process so that product quality can be maintain. Through this paper try to examined the various defects during capacitor manufacturing process by using fishbone and Pareto analysis. To analyze the various defects, three months data has been collected from October 2018 to December 2018 and analyze all the defects through fishbone and Pareto chart. The outcomes of the research show that the maximum problem was arises from the capacitor's winding and welding process and have to mainly focus on those area so that defects can be controlled up to maximum extend. To minimize all the defects, prepare fishbone diagram which shows all the root causes of defects and afterward analyze through pareto chart. Now follow some suggestive action to reduces the defects and improve the overall quality of the capacitors.

Keywords: Defects analysis, Fish bone diagram, Pareto diagram, Pareto Analysis.

I. INTRODUCTION

The tools and technique which is used for improve the quality is known as quality management tools and technique. This tool and technique is used to monitoring and control the process as well improve or redesign the process or product [1].The most commonly used tools and technique in quality purpose are as follows –

1) Fishbone diagram /Cause and effect diagram.
2) Pareto Analysis
3) Control charts
4) Scatter diagram
5) Control Charts.
6) Histogram.
7) Flow Chart

These tools are also known as seven basic quality tools, used to improve and monitoring the quality purpose. The procedure for implementing a quality system in any organization is very simple and many organizations are already working on it, because it gives tremendous advantages in all respects [4, 12]. Some are as below

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1) Increase customer's satisfaction level.
2) Reduce the product variations.
3) Improvement in manufacturing process.
4) Increase in productivity.
5) Reduce the rework activity.
6) Increase in financial performance.
7) Increase in market share.
8) Improve in internal or external communications activity.
9) On time delivery of product.

In the production, we can use the Pareto technique for analysis the performance of product or Process. This analysis can strengthen with the help of fishbone analysis, first identify the root cause through cause and effect diagram then cause can further studies through Pareto chart. Through some literature study, we can categories the product of any organization in 3 groups with their performance index shown by table-1, as discussed by Nicolae and Dumitrascu [10].

Table 1 – Product Categories

Product Categories	Performance index
First Categories	5-15%
Second Categories	20-30%
Third Categories	55-75%

II. CASE STUDY – AN OVERVIEW

This case study is performed at a capacitor Industry, where manufacturing the various types of capacitors on a large scale of 700 million pieces per annum.The process map (Fig.1) shows the various steps during manufacturing of capacitors which helps to understand the process in a better way.

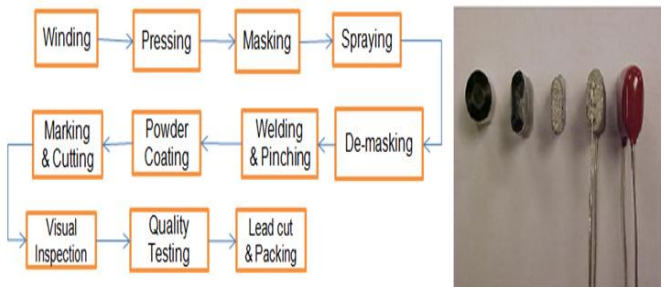

Fig 1: Process Map

The map shown all the manufacturing processes in a sequence manner to identify the flaws in the process and with the help of these flaws solve the problem with a better approach. This case study is carried out one of the largest Capacitor Industry in northern India. The contextual analysis depends on observing

and control of deformities for the assembling process.
The case study is based on monitoring and control of defects during the manufacturing process.

III. METHODOLOGY

This case study can be studies with the help of following tools

A. Pareto diagram

B. Fish Bone Diagram

A. Pareto Diagram

A Pareto Analysis is a way through which we can study the causes of the problem in any organization so that it can be analyzed and after that improvement could be taken place. It is based on the 80/20 principle, which says that 80 % of the output comes from the 20% inputs. It is the statistical approach in which we select those limited factors that would cause the problem in the production. Since there are various factors that would have an effect the output of the process but through Pareto analysis, we would sort some of the major factors that would contribute maximum to the defect [11, 14]

B. Fishbone Diagram

The fishbone chart gives complete information of all potential causes to recognize the root cause of the problem. The main advantage of this technique is that a clear understanding of the problem its causes and how much the problem is affecting the final output. It is also gives possible remedies to eliminate those root causes up to certain extent [7]. After analyzing all the defects through Pareto chart, we came to know that winding is the main process, others are welding and pressing, where maximum rejection were occurs around 28 %, 17% and 13% respectively. Therefore, we are mainly focus on the winding, pressing and welding process and try to analyze all the possible root causes through fish bone diagram and eliminate all the possible cause to reduce the rejection of the capacitors in winding, welding and pressing section [5, 13]

IV. IMPLEMENTATION OF PARETO AND FISH BONE DIAGRAM IN PRESENT PROBLEM

To identify the main problems, which cause frequent defects of manufacturing process. Three months of data had been collected from September 2018 to November 2018.The output of the company is various types of capacitors. The actual rejection is grouped in their respective type of defects identified [3, 6]. As discussed in the above, the pareto analysis is a simple tool to shows the various defects and help to identify most likely defect, months wise data has been collected and shown by the below table 2.

Table 2: Defects analysis (September, 2018)

Sl. No.	Type of defects	Defects Percentage
1	Winding	28.0
2	Pressing	13.0
3	Masking	6.0
4	Spraying	7.0
5	Welding	17.0
6	Burning	1.6
7	Powder Coating	4.0
8	Marking	2.2
9	Visual Inspection	3.5

If we analyze the Fig: 2 we would observe what are the major causes of defects in the month of September 18 and among the various factors winding, welding and pressing have the most significant effect. Winding has the total defect of 28% and after the winding there is welding that need to be controlled which has the defect percentage of 17% and pressing has the defect percentage of 12 %. The line that would start from the bottom left corner and ending in upper right corner, showing cumulative percentage. So analyze all the three major defects through fish bone diagram and try to find the proposed solution to counter it.

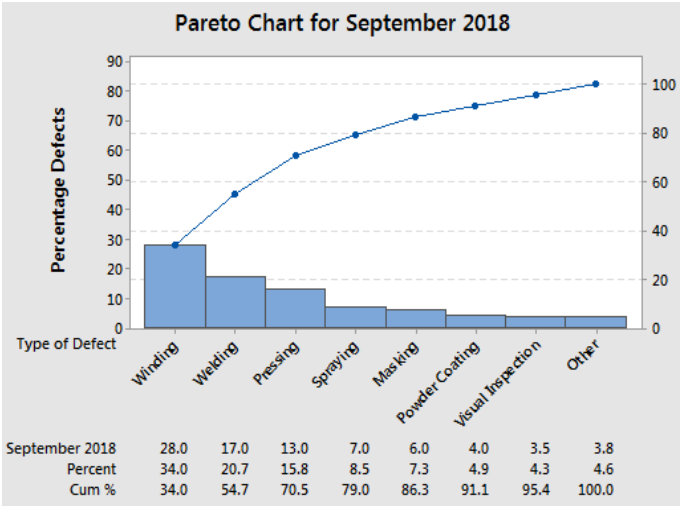

Fig 2: Pareto Analysis for September 2018 month

A. Fishbone Diagram of Winding Defect

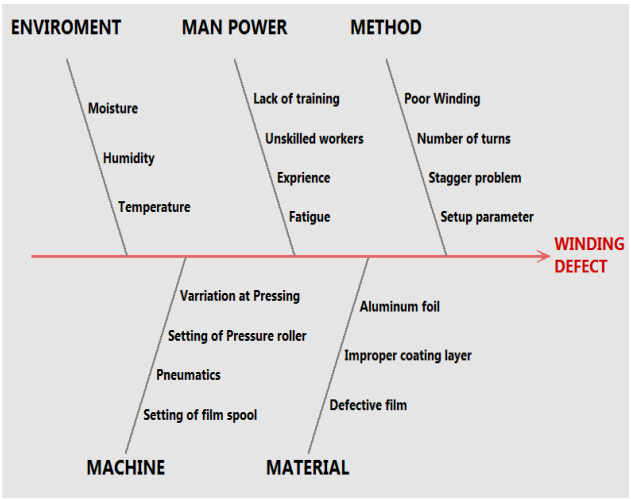

Fig 3: Fish Bone Diagram For Welding Defect

After gone through the fishbone diagram of welding defects, conclude the following proposed solution and implement those solutions in further production of capacitors.

Table 3: Action Plan Suggestion for Winding Defect Based on Fishbone Diagram

Type	Action plan suggestion for winding defect
Method	• Proper standard method should be followed and documented. • Maintain exact number of turn as per lot paper. • Avoid the stagger problem. • Standard setup parameter is followed during winding operation.
Machine and Setup	• Maintain proper pressing throughout the winding process. • Check roller movement on the regular basis and maintain proper air gap. • Set the stagger and free margin as per standard valve or as per given lot paper. • Prepare the check sheet for proper cleaning of rollers.
Material	• Must use raw material with appropriate quality. • Care should be given in load the film roll on machine. • Check the material coating layer time to time during winding operation.
Man Power	• Must have good attitude toward quality improvements. • Operator should be sufficiently trained for winding process. • One experience person should be assigned for quality check during operation. • Training should be provided time to time for improve the operation. • Should have sufficient / experience knowledge to identify the problem if any.

B. Fish bone diagram of Welding Defect

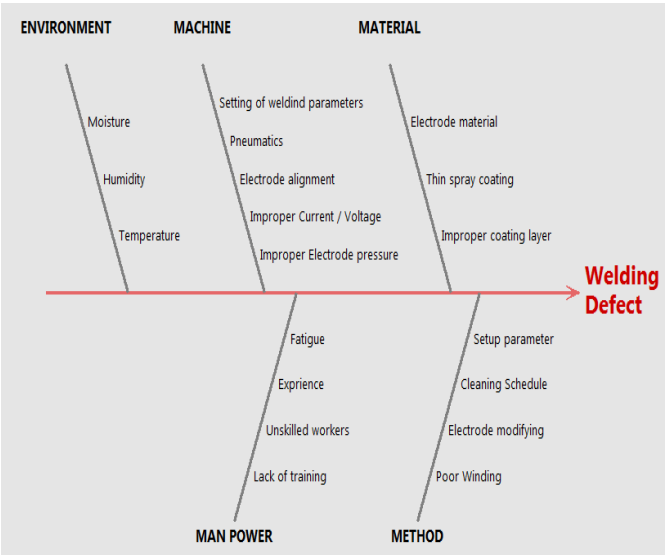

Fig 4: Fish bone diagram for welding defect

Table 4: Action plan suggestion for welding defect based on fishbone diagram

Type	Action plan suggestion for welding defect
Method	• Proper standard method should be followed and documented.
	• Maintain and monitoring cleaning schedule after each lot. • Not allowed any modification in electrode during welding. • Standard setup parameter is followed during winding operation.
Machine and Setup	• Maintain and monitoring proper setting of welding parameter before use. • Check the Pneumatics system before welding operation. • Maintain the proper electrode alignment during welding operation. • Maintain and monitoring proper current and voltage supply during operation. • Maintain proper electrode pressure.
Material	• Must use proper electrode material during welding. • Care should be taken during welding for thin spray coating capacitors. • Check proper coating layer on electrode.
Man Power	• Operator should be sufficiently trained for welding process. • One experience person should be assigned for quality check during operation. • Training should be provided time to time for improve the operation. • Must have good attitude toward quality improvements. • Should have sufficient / experience knowledge to identify the problem if any.

C. Fish bone diagram of Pressing Defect

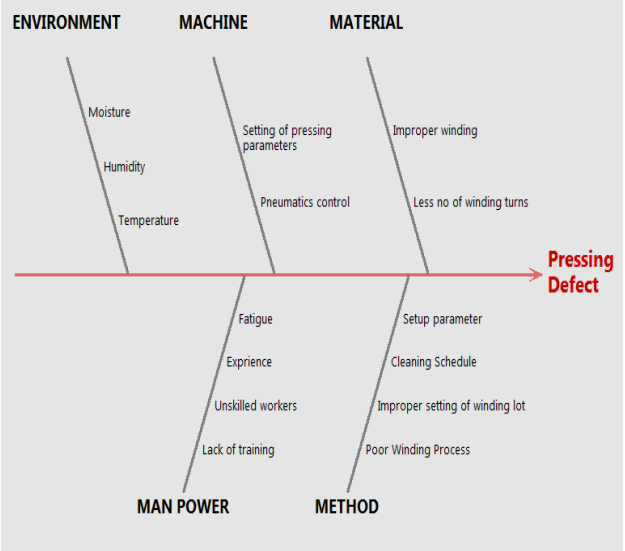

Fig 5: Fish bone diagram for pressing defect

Table 5: Action plan suggestion for pressing defect based on fishbone diagram

Type	Action plan suggestion for pressing defect
Method	• Proper standard method should be followed and documented. • Maintain and monitoring cleaning schedule after each lot. • Care should be taken for proper placing of winding lot for pressing. Standard setup parameter is followed during operation.
Machine and Setup	• Maintain and monitoring proper setting of pressing parameter before use. • Check all the Pneumatics control system before pressing operation.
Material	• Avoid improper winding lot for pressing operation.
Man Power	• One experience person should be assigned for quality check during operation. • Training should be provided time to time for improve the operation. • Must have good attitude toward quality improvements. • Should have sufficient / experience knowledge to identify the problem if any.

V. RESULT AND DISCUSSION

After analyzing the major root causes through Pareto chart and fish bone diagram, action plan with suggestive solutions be drawn. Action plan need one to two months execution for data collection. Data was collected for the months of October 2018 and November 2018 and drawn the Pareto diagram. The Pareto diagram shows that there was some improvement in winding, welding as well as pressing operation.

A. Pareto chart for October month

Table 6: Defects analysis (October, 2018)

Sl. No.	Type of defects	Defects Percent
1	Winding	27.24
2	Pressing	12.12
3	Masking	5.60
4	Spraying	6.40
5	Welding	16.47
6	Burning	1.40
7	Powder Coating	3.80
8	Marking	2.12
9	Visual Inspection	3.30

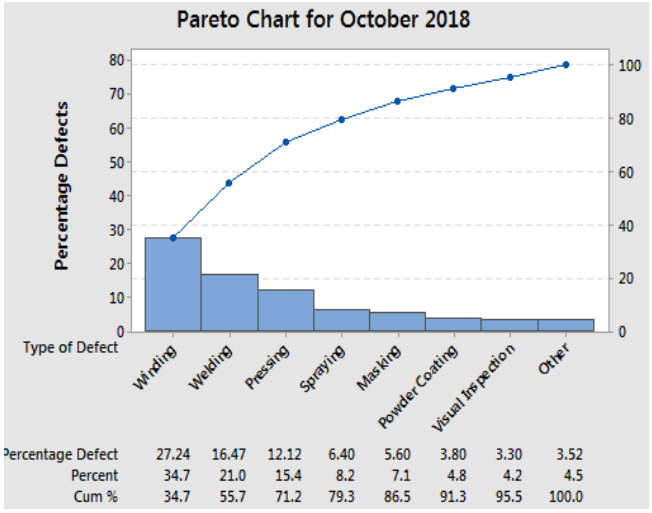

Fig 6: Pareto Analysis for October 2018

- After implementing above suggestive action plan, it is noted that there is decrease in rejection level of winding, welding and pressing.
- It is also observed that these defects has higher impact on other defects too because if there is decrease in the rejection level of winding, welding and pressing then other defects such as spraying, masking etc. also decreased or controlled to some extent.

B. Pareto chart for November month

Table 7: Defects analysis (November, 2018)

Sl. No.	Type of defects	Defects Percent
1	Winding	26.82
2	Pressing	11.76
3	Masking	5.30
4	Spraying	6.10
5	Welding	16.12
6	Burning	1.20
7	Powder Coating	3.50
8	Marking	1.95
9	Visual Inspection	3.16

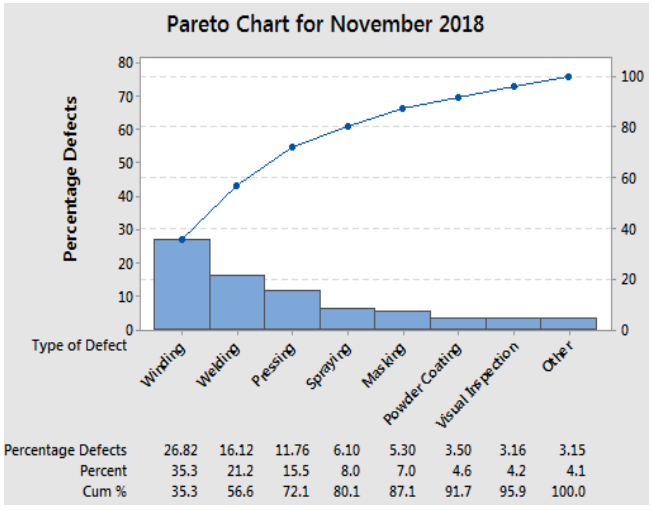

Fig 7: Pareto Analysis for November 2018

Figure 7, clearly states that after followed the suggestive solution there is continuous improvement in winding, welding and pressing operation. The defect percentages were decreased as well as others defects were also decreased.

C. Comparison of the Defects analysis

With the concept of Pareto and fish bone analysis, the root causes of the capacitor's defects is observed and analyzed one by one. Implementation of suggestive action in production process and analysis is shown the Table 8. Now we have observed that the major defects like winding, pressing and welding are continuously reduced. Also reduces the other defects up to some extent.

Table 8: Comparison of defects analysis

Type of Defects	September 2018	October 2018	November 2018
Winding	**28.0**	**27.24**	**26.82**
Pressing	**13.0**	**12.12**	**11.76**
Masking	6.0	5.60	5.30
Spraying	7.0	6.40	6.10
Welding	**17.0**	**16.47**	**16.12**
Burning	1.6	1.40	1.20
Powder Coating	4.0	3.80	3.50
Marking	2.2	2.12	1.95
Visual Inspection	3.5	3.30	3.16

VI. CONCLUSION

A Pareto chart and fishbone diagram are used to shown major defects which occurring frequently. The defects can be evaluated and implemented through suggestive action and result was documented. Hence, quality of capacitors is improved using fishbone and Pareto Diagram, resulting high control in defects and improved capacitors manufacturing process.

After using fishbone diagram and Pareto diagram outcomes are listed below:

1. Problems are identified and prioritized the major cause effectively.
2. Establishment of the needs of various practical applications such as improve the process level, customer needs and satisfaction, suppliers needs, investment opportunities etc.
3. Improve the process/product by apply the efforts in right direction.

After implementing the necessary measures to minimize or eliminate the categories of defects. Pareto diagram and comparison of defects table 8 is shown above that verifies the effectiveness of actions plan suggested in the research.

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Mr. Ravi Shankar Raman Graduated in Mechanical Engineering from Visvesvaraya Technological University, post graduation in Manufacturing and Automation Engineering from Maharshi Dayanand University and pursuing Ph.D from Visvesvaraya Technological University in the field of Six Sigma and quality system. At present, he is working as associate professor in ABES Engineering College, Ghaziabad and working towards the design and quality aspects in different industries in and around Ghaziabad. He has 14 years of teaching experience. He published around 15 research papers in renowned journals and attended many international/national conferences. Awarded as a Best Mentor's for project "Reshaping flight for fuel economy" in Simulation & Scale Model Category. He has sound knowledge in design software like AutoCAD, Solid Work, and Ansysis and got international certification in Autodesk, CSWA, CSWP, and Six Sigma-Greenbelt.

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