DOWEL JOINT DEFECT IN MCB TERMINAL -DMAIC METHOD OF SIX SIGMA

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ABSTRACT

Abstract: *In this competitive generation, six sigma is a very useful and powerful business strategy method to improve production and reduce deficiency. The Six Sigma DMAIC problem-solving technique is one of the best techniques used by organizations to improve their regular production parts. In this paper, we executed the Six Sigma DMAIC technique to improve the production and reduce rejections in the dowel joint of the terminal component used in MCB.*

Keywords: - *Six Sigma DMAIC, Miniature Circuit Breaker, Dowel Joint, Terminal Connector, Conventional Mechanical press, Multi-slide stamping machine*

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1. INTRODUCTION

Six Sigma is the most used quality and process improvement methodology, which helps in the elimination or significant reduction of defects in the processes. The main motive of six sigma is to reduce the occurring variations present in products and processes. The term 'Sigma Quality Level' is used as an indicator that tells us about process efficiency or 'Lower Sigma Quality Level' means that there is a greater possibility of defects in that specific product, on the other hand 'Higher Sigma Quality Level' means that there are lower chances or the possibility of defective products within the process.[1]

1.1 Identification of the problem: The study focuses on the dowel joint in the terminal is a crucial point in the terminal component of MCB (Miniature Circuit Breaker) where it should withstand 4.5 N/m torque. When the terminal is produced with the conventional press of 5 stages, the joint is having irregularity in shape and is unable to withstand the specified torque; also, the productivity achieved by the conventional press is very less (approximately 0.2 million components per requirement). The Miniature Circuit breaker's function is to break off the current flow after a fault is detected. Unlike a fuse, which operates once and then must be restored, a circuit breaker can be rebooted (as MCB is automatically or manually switched on) to resume normal operation.

1.2 Analysis of the existing system: As the requirement cannot be met with the existing traditional mechanical press, a new approach of having a single component in one stroke needs to be revised. Taking into consideration of the customer demand of approximately 1 million components per batch, the DMAIC method is implemented for us to review and verify the effectiveness of the new method as well.

1.3 Probable solution: Commercially feasible investment and technologically reliable system has been verified and implemented in the form of a Multi-slide stamping tool on the machine GRM 80 E, which provides high productivity.

2. MINIATURE CIRCUIT BREAKER AND TERMINAL CONNECTOR

2.1 Miniature Circuit Breaker: MCB is a time-delay tripping device. In these types of devices, the operating time is measured and controlled by the magnitude of the overcurrent passing through it. This means that the device functions when there is an overload for a longer period, it is long enough to endanger the circuit being protected by currents or switching surges. Generally, these types of devices are designed to operate at less than 2.5 msec (milliseconds) when there are short circuit faults and between 2 seconds to 2 minutes in case of overloads.

2.2 Terminal connector component of MCB: The provided terminal is extensively used to secure and connect wires in a spark-free manner in different kinds of miniature circuit breakers.

The terminal produced has specifications as follows:

- Raw Material: C45
- Sheet metal thickness: 1.5mm
- Hardening process: 36-38 HRC
- Plating: copper- CU 2-3, nickel-(micron 4-6)

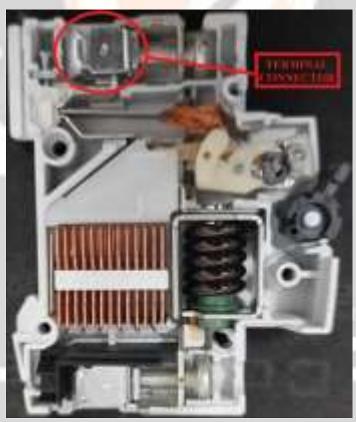

Fig-1: Terminal Connector position in MCB

3. DEFINE STAGE IN DMAIC

3.1 Problem Statement: The terminal component of MCB has a crucial Dowel joint. The defect in this joint (as the joint is needed to withstand 4.5 N-m Torque) results in functional failure and can result in short circuits condition.

Fig -2: OK Terminal profile

4. MEASURE STAGE IN DMAIC

4.1 Conventional Press and its limitations for Terminal connector: The working principle of the conventional powder press allows for the production of the terminal in 5 stages. The output of the mechanical conventional press is to release the force on the material and therefore press the sheet so that we can obtain the required shape with optimum precision. [2]

But the precision is low and the stages necessary for the Terminal connector are too many. Eventually, this results in productivity that is too low with respect to the requirement. The analysis of the same is done in 'CoPQ'

4.2 Cost of Poor Quality: Companies try to develop and produce such types of products or services that [1]will meet the customer's requirements, with low cost and higher quality. To be able to continuously improve quality, companies need to be aware of costs due to poor quality and the resources needed to work on quality improvement. [3]

To be able to improve product quality and increase staff engagement in making improvements it is essential to start measuring present quality. Without measurements, it is impossible to have crucial input to quantify the various factors necessary for the determination of actual costs for various factors.

4.3 Cost of Poor Quality for the terminal component: Our traditional method of mechanical press produced **1milions** of dowel joints in 7 months in which rejection of dowel joint was **475** numbers. As the rejection is alarming and the productivity of the machine is very low the decision for the new system is to be developed. The rejected dowel joint profile is as shown below:

Fig-4: Ok profile of Terminal dowel joint

Fig-5: Not Ok profile of Terminal dowel joint

Month (Year 2021)	% Rejections
January	0.062
February	0.023
March	0.050
April	0.047
May	0.046
June	0.043
July	0.040

Table-1: Before rejection

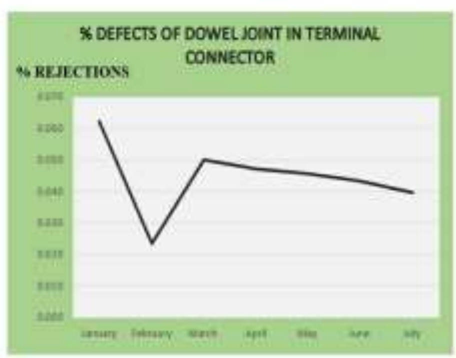

Chart-1: Percent Rejections (Before)

5. ANALYSE STAGE IN DMAIC

Root cause analysis is used to identify root causes for problems or defects when a project has reached the analysis phase without a clear idea of the primary cause. An Ishikawa diagram is a diagram that displays the cause and effect of a situation or case. It is mostly used in manufacturing and product development to find the different steps in a process, to demonstrate where quality control issues might arise, and to find what type of resources are required at that specific time.
The Ishikawa diagram was first used by Kaoru Ishikawa in 1960 to measure quality control processes in the shipbuilding industry. If there are possible root causes, they must be verified if the causes are valid. The main cause of the problem can be foot using various methods like statistical analysis, design of experiments, logical questioning, observing a process, gathering additional information, analyzing data with the help of graphical representation, and mapping processes in a defined manner.

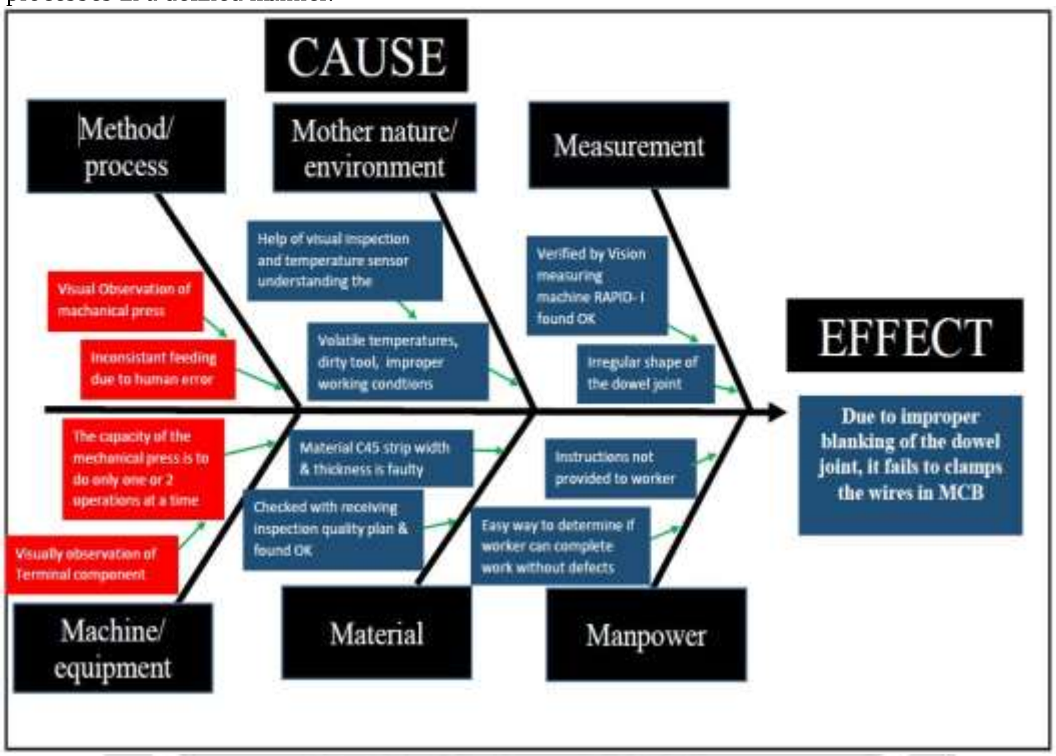

Fig-5: Why -Why Analysis for Dowel joint defect in Terminal Connector

Upon verification of the cause-and-effect diagram, it is seen that the two major contributing factors for defect are Method (Conventional hand feeding of sheet) and Machine (Conventional Mechanical Press). Thus. Successfully implication is that we need to have a strong feeding and automatic process which will provide a solution to the dowel joint problem.

Based on the observations made in the “ANALYSIS”, the main concerns are manual sheet feeding and less capability of manual mechanical press for higher productivity (found by Root-Cause analysis). As it is apparent that the existing system is unable to produce the required capacity needed to fulfill the higher productivities, the process of formulating a proposal for the new system to implement a strong solution is carried out.

6. IMPROVE STAGE IN DMAIC

Looking at the various parameters like space, the background of the company, capability, machinery, manpower, and the investment needed to be done by the company for the new system, the probable solution is Stamping and forming machine i.e., Multi-slide machine GRM 80E, which is included in the existing machinery of the company.
After the decision was approved, the designing stage and the manufacturing stage were achieved. The tool is to be produced and the quantity is increased from 1 million in 7 months (before) to 2 million in 15 days.

6.1 Improvement: The improvement can be seen in the below table. The PPM (parts per million) has fallen below 1000 PPM.

As the process is stabilized and the quantity of parts is increased from 1 million in 7 months to 2 million in 15 days, the system is found effective.

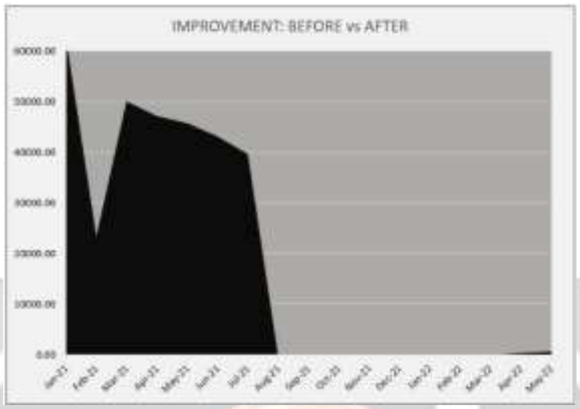

Chart-2: Improvement Before and after

7. CONTROL STAGE IN DMAIC

“Control” is the crucial stage where continuous verification is needed to support the claim for stabilization of the process. This general activity is carried out with Process capability analysis. Process capability (Cp) is related to the uniformity of the process. It is a measure of a process's ability to produce parts within the specified limit.

8. CONCLUSION

We hereby conclude that the defect of the dowel joint problem can be solved by having a Multislide machine

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