

A Case Study on Engine Stop Switch Problem Using QC Tool

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ABSTRACT

This present study / research paper deals with various aspects of Quality control tools and how the problem can be identified to find out root cause of the problem by using quality control tools in an organization and such types of related industries. The paper describes a case study of quality control tool & its implementation for removing the top most rejection PPM (Parts Per Million). The paper also presents comprehensive discussions of various steps of root cause identification, featured quality tools, improving the profitability, inspiration towards work and the critical thinking systems utilizing quality tools. The assembling business has encountered in extraordinary level of progress over the most recent three decades. The ongoing focused patterns have been pushing manufacturing, directors to reevaluate the effect and significance of expanding gear accessibility and use, increasing maintenance productivity, reduced rejection ratio, asset usage, and expanding and responsiveness of upkeep benefits in accomplishing world class status to meet worldwide challenge by utilizing Quality Circle (QC) Tools. There is a requirement for improving the cooperative energy between upkeep work and other authoritative quality improvement activities in the associations, to build up support as an aggressive technique of gathering the difficulties of exceedingly focused situations. Before the implementation of QCM, the study of process of problem identification is carried out.

1. Introduction

In modern era, Development of new management techniques has taken place all over the world which led to formation of complex production management system. Thus industry has to face many challenges due to increase in the product complexity. To face these challenges the liability regarding product quality has continuously moved from administrator to quality control division. Before quality was checked with the help of quality control tools such as sampling plans, control charts and statistical quality control techniques, but now 'Quality Circles' is one of the quality control methods which have been generally utilized by the associations to accomplish great quality and agreeableness among the clients. "Quality Circle is a small group of employees in the same work-area or doing a similar type of work who voluntarily meet regularly for about an hour every week to identify, analyse and resolve work-related problems, leading to improvement in their total performance, and enrichment of their work life" (Udupa

1986)[10]. "Quality circles are a formal, institutionalized mechanism for productive and participative problem-solving interaction among employees" (Lozano & Thompson 1980)[5]. "Quality control circle is not just a small room adjacent to the factory floor, whose occupants make a nuisance of themselves to everyone else. It is a state of mind and a matter of leadership with everyone from the president to production trainee involved" (Rehder 1981)[6]. Quality as "value to some person" (Weinberg 1991) [12]. "Quality of a product or service is the ability of the product or service to meet the users' requirements" (Sarkar 1995) [13]. Among the most widely recognized are that quality circles are utilized exclusively to unravel item quality issue, that there is a need to prepare just shop floor representatives since administrators and bosses as of now have the required preparing, that the quality circle idea requires replicating of everything about the Japanese practice, also, that specialists in effective quality circle ventures must be remunerated by monetary prizes (Olga L. Crocker 1986)[9].

Table 1: Quality Gurus and Their Contributions [14].

Quality Guru	Main Contribution
Armand V. Feigenbaum [1]	Introduced concept of total quality control.
Genichi Taguchi[2]	Focused on product design quality.
	Developed Taguchi loss function.
Joseph M. Juran [3].	Defined quality as "fitness for use."
	Developed concept of cost of quality.
Philip B. Crosby [4]	Coined phrase "quality is free."
	Introduced concept of zero defects.
W. Edwards Deming [7]	Stressed management's responsibility for quality.
	Developed "14 Points" to guide companies in quality
Kaoru Ishikawa [8]	Developed cause-and-effect diagrams.
	Identified concept of "internal customer."
Walter A. Shewhart [11]	Contributed to understanding of process variability.
	Developed concept of statistical control charts.

The general introduction of significant worth circle and its impact[15]. Notwithstanding their utilization of the seven QC tools, QC Circles are emphatically prescribed to utilize other critical thinking and thought age strategies such as conceptualizing, the why-why approach, partiality charts, 5S, 3Mu, 5W1H, and 4M1E to help them in their QCC usage[16]. Organizations are adequately trying to incorporate grass root specialists in persevering improvement[17]. Quality circle is an instrument for increment representatives execution and connecting laborers to the procedure of basic leadership and seven basic tools[18]. The research is about the impacts of value control on Nestle Waters' representatives' observation and frames of mind. Enlightening examination was utilized for this exploration alongside the utilization of instruments like survey, unstructured meetings, narrative investigation[19]. To consider the components which help in usage of Quality hover for the achievement of association[20]. This paper intends to see how the writing on nonstop improvement, including circles (QCs), SGAs (small group activities), and CICs (continuous improvement cells), can direct the assessment of constant improvement programs[21]. Manages the Quality Circle Case study completed at Tecumseh Product Company Compressor Assembling division[22]. This investigation is to decide if QCs in one part are performing more viably than the other[23]. The impact of value control hover execution on organization execution in development industry[24]. The use of QCC in an affiliation that can improved profitability of the association. Concentrate more on impact of QCC usage, procedure of usage and components that help to improve efficiency to fulfill client need[25].

2. Industrial Concept For Quality Circle : A Case Study

Methodology Adopted

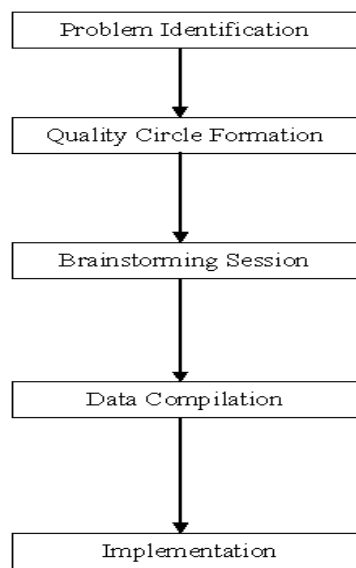


Figure 1: Methodology Adopted.

3. Objective of the study

The contextual analysis has following targets:

- To provide sound discussion on Problem solving Methodology and to see how this tool can be implemented in the organization to achieve operational excellence in manufacturing industry,
- To improve generation by conceptualizing for decrease in non-esteem included work through ramifications of ceaseless improvement.
- To dissect the substantial and elusive advantages of value hovers usage over assembling ventures.
- To legitimizes the noteworthy job of value hovers execution for quality improvement and examine shop floor results after usage of quality circle.
- To give a sound exchange on quality circle usage and perceive how this technique fit in with quality improvement and operational brilliance activities in assembling ventures.
- To energize and propel organization worker to give profitable recommendation to progress in any of the working zone.

4. Present Work Case Study

THE CASE STUDY IN MINDA INDUSTRIES IMT MANESAR, GURGAON, HARYANA, INDIA. THE PROBLEM IS IDENTIFIED AS FLICKERING OBSERVED IN ENGINE STOP SWITCH IN SWITCH HANDLE.

- 1) Identification and Categorization of Problems
- 2) Identification of the Causes
- 3) Analysis of the Problem
- 4) Developing Solution

- 5) Foreseeing Probable Resistance
- 6) Trial Implementation / Checking the Results
- 7) Regular Implementation
- 8) Follow – Up- Review.

1. **IDENTIFICATION AND CATEGORIZATION OF PROBLEMS:** Flickering observed in Engine stop Switch in switch handle.



Figure 2: Problem definition

5W-2H Analysis

Table 2: 5W-2H Analysis

Who	Who found the problem?	Customer
What	What part has the problem? (object) Model and type.	Engine Stop Switch in SW. Handle 2
	What is wrong with it? (defect) Symptom of problem. Use illustrations to clarify.	Flickering in Engine Stop Switch
Where	Where was the part located when you found the problem?	Japan
	Where on the part is the trouble located?	Engine Stop Switch
When	When was the problem first found? Date and Time.	01/02/2016
Why	Why is it a problem ?	Function loss in switch
How	How was the problem found? Visual inspection or customer complaint?	Customer Complaint
How Many	How many parts or units have this problem?	1

Engine Stop Switch Part Details

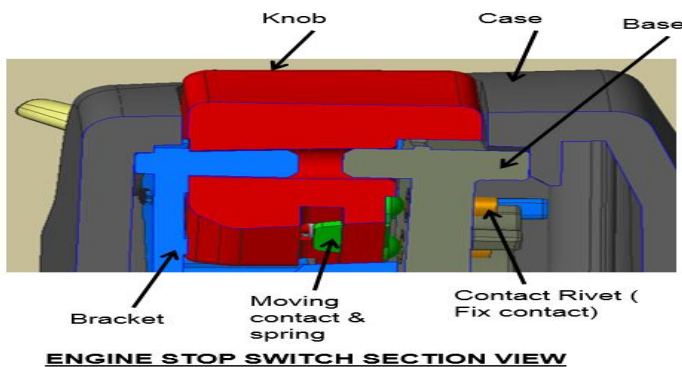


Figure 3: Engine stop switch section view



Engine Stop Module assy in Case

Figure 4: Engine stop module assembly failed sample

5. Identification of the Causes:

- 1. Less Contact Pressure
- 2. Oxidation on Contacts

With the help of **Cause & Effect diagram**, various possible causes observed

Measurement-

1. Base dimensions is out of specification
2. Gap between base and case not as per standard
3. Case dimension is out of specification
4. Bracket dimension is out of specification
5. Moving contact dimple height is out of specification

Material-

1. Spring load not as per drawing.
2. Moving Contact fitment NG.
3. Contact rivet position in base is not as per drawing.
4. Non Conductive materials in between contacts.
5. Moving contact dimple height is out of specification.

Man-

1. Operating Guidance sheet not followed.
2. Design standard not followed.

Method-

1. Moving contact floating is not proper.
2. Improper fitment of moving contact in knob
3. Improper fitment of base in case.
4. Loose Soldering.

Machine-

1. Continuity machine is not adequate to detect flickering.
2. Air pressure in riveting fixture is not adequate

6. Cause & effect Diagram

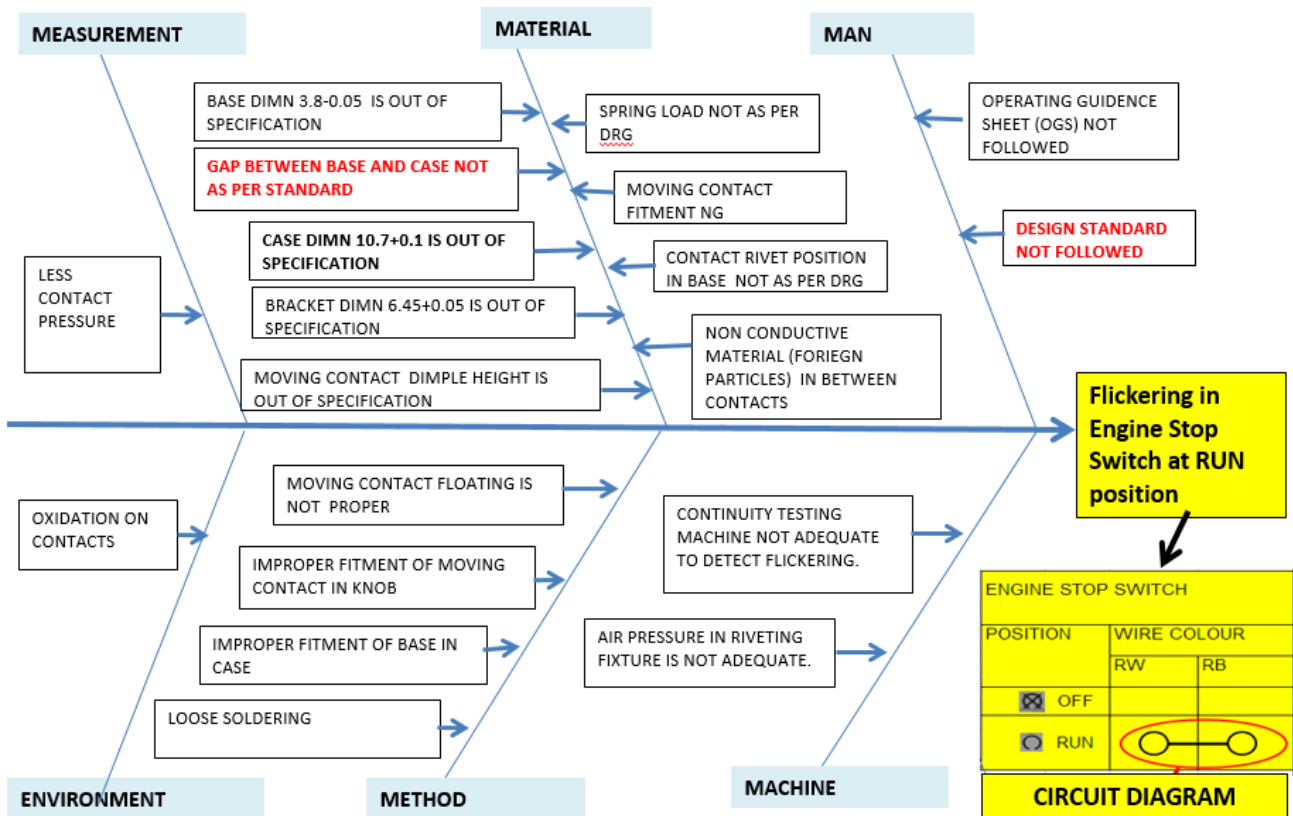


Figure 5: Cause & effect Diagram

7. Possible causes verification

Table 3: Possible causes verification

	Possible Causes	Verification
MAN	OPERATING GUIDENCE SHEET (OGS) NOT FOLLOWED	OPERATOR GUIDENCE SHEET FOLLOWED : PROCESS PARAMETER AND CHECK POINT RECORD FOUND OK
MATERIAL	BASE DIMN 3.8-0.05 mm IS OUT OF SPECIFICATION	OBSERVED 3.8
	CASE DIMN 10.7+0.1mm IS OUT OF SPECIFICATION	10.7
	BRACKET DIMN 6.45+0.05 mm IS OUT OF SPECIFICATION	6.35
	MOVING CONTACT DIMPLE HEIGHT IS OUT OF SPECIFICATION	DIMPLE HEIGHT FOUND OK
	SPRING RATE : 0.394 ± 10% kgf/mm, SPRING LENGTH: 4.6±0.2 mm	SPRING RATE: 0.39 SPRING LENGTH: 4.74
	MOVING CONTACT FITMENT NG	MOVING CONTACT PROPERLY FITTED
	CONTACT RIVET POSITION IN BASE NOT AS PER DRG	CONTACT RIVET POSITION FOUND OK
NON CONDUCTIVE MATERIAL (FORIEGN PARTICLES) IN BETWEEN CONTACTS	NO FOREIGN PARTICLES OBSERVED ON CONTACTS	

Table 4: Possible causes verification

	Possible Causes	Verification
MEASUREMENT	LESS CONTACT PRESSURE: SPEC: 275 gf MIN FOR 2 CONTACT POINTS	NO CONTACT PRESSURE ON CONTACTS
ENVIRONMENT	OXIDATION ON CONTACTS	NO OXIDATION OBSERVED ON CONTACTS
METHOD	MOVING CONTACT FLOATING IS NOT PROPER	MOVING CONTACT FLOATING FOUND OK
	IMPROPER FITMENT OF MOVING CONTACT IN KNOB	MOVING CONTACT FITMENT FOUND OK
	IMPROPER FITMENT OF BASE IN CASE	BASE FOUND INCLINED
	LOOSE SOLDERING	SOLDERING STRENGTH FOUND OK
MACHINE	CONTINUITY TESTING MACHINE NOT ADEQUATE TO DETECT FLICKERING.	DEFECTIVE SAMPLE TESTED ON TESTING MACHINE AND FLICKERING DETECTED
	AIR PRESSURE IN RIVETING FIXTURE IS NOT ADEQUATE	AIR PRESSURE FOUND AS PER STANDAEED

Main Causes: Gap between base (Pivot pin) and case not as per Standard: Gap required as per std: 0 to 0.2mm, Actual observed -0.55mm

Reason: Dimensions of Bracket: 6.45+0.05, Case: 10.7+0.1 and Base :3.8 -0.05 are not adequate to meet the gap as per design standard.

3. ANALYSIS OF THE PROBLEM: Verification of base tilting effect due to gap between base and case due for continuity missing/flickering



Figure 6: Flickering / continuity missing observed in base tilting condition



BASE PIVOT SIDE.

Figure 7: No flickering / continuity missing observed when base pressed by 0.51 mm from base pivot side.

Why-Why Analysis: -

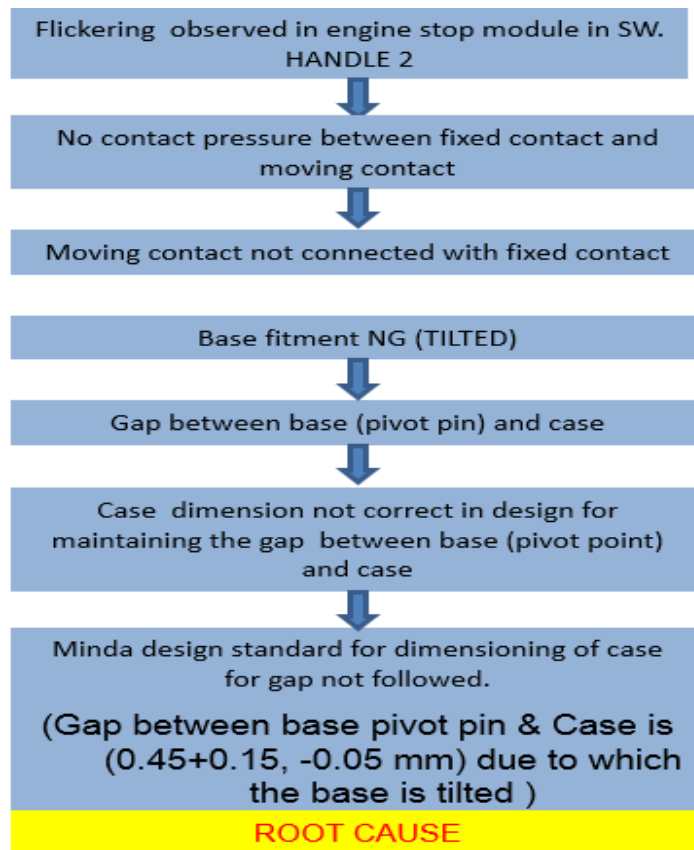


Figure 8: Why-Why Analysis

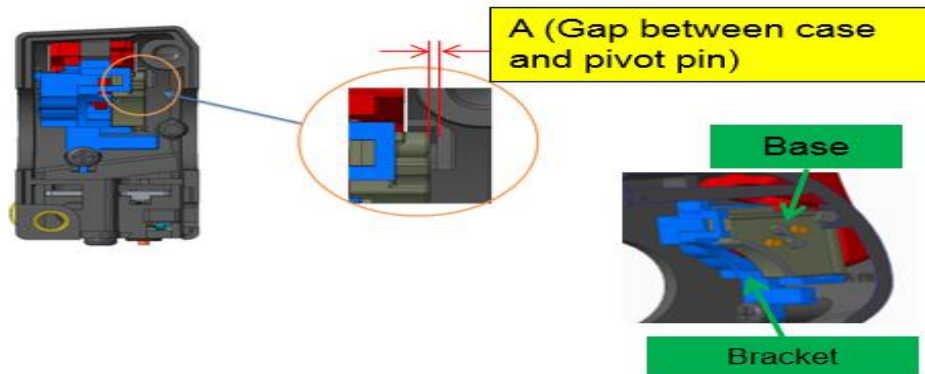


Figure 9: Gap between case and pivot pin

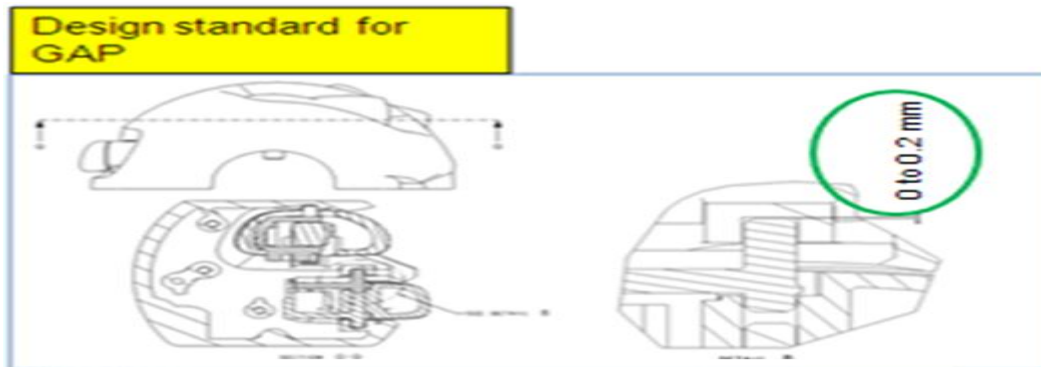


Figure 10: End clearance between Pivot Pin of Bracket/ Base with case

4. DEVELOPING SOLUTION:

Design Calculation for Gap Analysis for Case and Base pivot, "A"

	<p>GAP "A" Before Case Modification</p> <p>As per Design Tolerances</p> $\text{Gap, A} = 10.7^{+0.1} - (6.45^{+0.05} + 3.8^{-0.05})$ $= 10.7^{+0.1} - 10.25 \pm 0.05$ $= 0.45^{+0.15/-0.05}$ <p style="border: 1px solid red; padding: 2px;">$= 0.40 \sim 0.60\text{mm}$</p> <p>As per Actual Part Dimension</p> $\text{Gap, A} = 10.7 - (6.35 + 3.8)$ $= 10.7 - 10.15$ $= 0.55\text{mm}$	<p>GAP "A" After Case Modification</p> <p>As per Design Tolerances</p> $\text{Gap, A} = 10.3^{+0.1} - (6.45^{+0.05} + 3.8^{-0.05})$ $= 10.3^{+0.1} - 10.25 \pm 0.05$ $= 0.05^{+0.15/-0.05}$ <p style="border: 1px solid green; padding: 2px;">$= 0 \sim 0.2\text{mm}$</p> <p>As per Actual Part Dimension</p> <p>#</p> $\text{Gap, A} = 10.20 - (6.35 + 3.8)$ $= 10.20 - 10.15$ $= 0.05\text{mm}$
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Figure 11: Design Calculation for Gap Analysis for Case and Base pivot, "A"

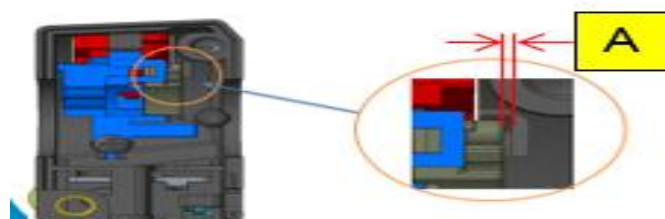


Figure 12: Developing the solution

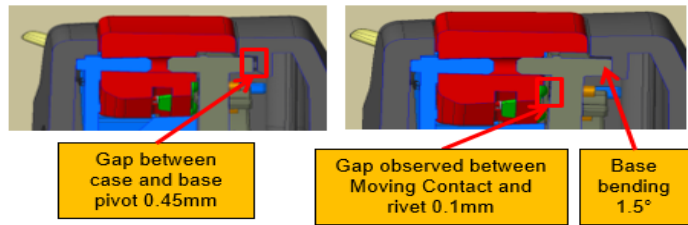
Countermeasure: -Case dimension to be changed from 10.7+0.1 to 10.3+0.1 to maintain the gap 0 to 0.2mm.
 #Dimension 10.2 against 10.3+0.1 accepted due to gap is within specified limit.

Contact Pressure Calculation (After Base Bending)-

Contact Pressure required:
 Rated Current: 4.5A
 Contact Pressure Required per dimple = $(100+25/3 \times 4.5) \text{ gf} = 137.5 \text{ gf}$
 Total Contact pressure required for 2 dimple = $137.5 \times 2 = 275 \text{ gf min.}$

Contact Pressure as per design:
 Spring rate: 394 gf/mm
 Spring free length: 4.6mm
 Spring operating Length: 3.4mm

Contact Pressure = $394 \times (4.6-3.4) = 472.8 \text{ gf}$



Condition for flickering: At 0.45mm gap, 1.5° base bending observed in design. Gap between moving contact and rivet observed 0.1mm which leads to contact flickering.

Figure 13: Contact Pressure Calculation (After Base Bending).

Contact Pressure Calculation (Without Base Bending)-

Contact Pressure required:
 Rated Current: 4.5A
 Contact Pressure Required per dimple = $(100+25/3 \times 4.5) \text{ gf} = 137.5 \text{ gf}$
 Total Contact pressure required for 2 dimple = $137.5 \times 2 = 275 \text{ gf min.}$

Contact Pressure as per design:
 Spring rate: 394 gf/mm
 Spring free length: 4.6mm
 Spring operating Length: 3.2mm
 Contact Pressure = $394 \times (4.6-3.2) = 552 \text{ gf}$

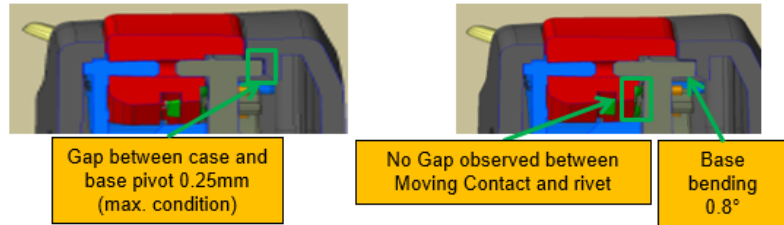


Figure 14: Contact Pressure Calculation (Without Base Bending).

No flickering observed during testing (operation durability test and vibration durability)

Design validation status after modification in case

Report copy of operation durability test attached for ref.

Vibration durability and continuation operation durability testing done and result found satisfactory

Countermeasure Summary-

Problem-

Flickering observed in engine stop switch at run position

Root Cause-

Gap between base and case observed 0.55mm

Counter measure-

1. Case-Drawing to be amended for dimension 10.7+0.1 to be changed to 10.3+0.1 to maintain the gap 0 to 0.2 mm
2. Case tool correction.
3. Design validation in Lab testing.
4. Fmea Updation.

Table 5: Implementation Summary

PROBLEM	ROOT CAUSE	COUNTERMEASURE	TARGET DATE	ACTUAL STATUS
FLICKERING OBSERVED IN ENGINE STOP SWITCH AT RUN POSITION	GAP BETWEEN BASE AND CASE OBSERVED 0.55 mm	CASE : DRG TO BE AMENDED FOR DIMENSION 10.7+0.1 TO BE CHANGED TO 10.3+0.1 to maintain the gap 0 to 0.2 mm	12/12/15	DONE ON 12/12/15
		CASE TOOL CORRECTION	25/12/15	DONE ON 28/1/16
		DESIGN VALIDATION IN LAB TESTING	29/2/16	UNDER TESTING
		FMEA UPDATION	12/12/15	DONE ON 12/12/15

6. FORESEEING PROBABLE RESISTANCE: Changes are not easily accept. to the people. Various departments make objection of it but after seeing the result of trial conducted, everyone got convinced. For instance

- **Production:** Our line will get disturbed if the changes will occur.

- **Tool Room:** We have already many projects to do. Don't have time for R&D works
- **Design:** The design we have to validate & approval to be taken by customer, which is difficult for us.

7. TRIAL IMPLEMENTATION/ CHECKING THE RESULTS: After taking corresponding Corrective Actions, there is a significant fall in PPM

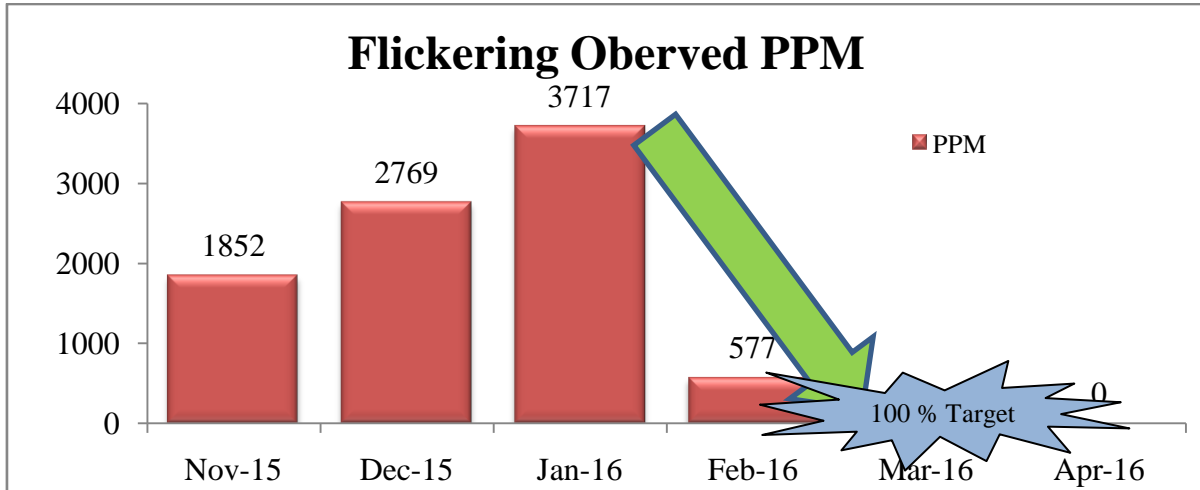


Chart 1: Trial Implementation

8. REGULAR IMPLEMENTATION: For ensuring the changes that are made, should be reflect in Standards. Standardization through 5W & 1H is given as:

Table 6: Regular Implementation

Why? (Objective)	What (Item)	When (Period)	Who (Person)	Where (Place)	How (Method)
Flickering	Case	On daily basis	Quality Engg.	At lab	As per Check sheet
Adequate skill	Case dimension Measurement	Every Batch	IQC Inspector	At receiving Stage	By Gauge

- PDI standard of supplier & IQC Standard updated for measuring total length of bush.
- In-process Inspection Standard updated for measuring total length of bush.

9. FOLLOW-UP REVIEW: Report based upon follow up & reviews of last two months.

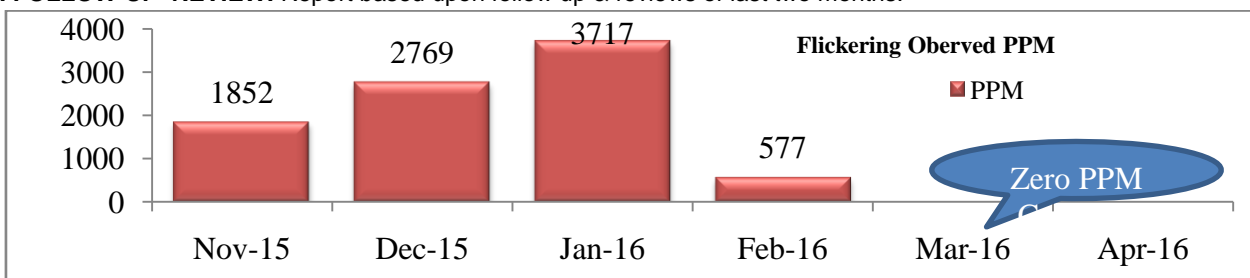


Chart 2: Follow up & Reviews

9. Overall Result Analysis

The result investigation is done based on adequacy of QCM by lessening PPM Level of the considerable number of items from a gigantic amount of all out 3717 to a base amount of complete 577 which expected to wind up zero in the following month. The QCM wiped out the significant benefactor of issues for before the implementation of QCM. Problem is identified as flickering observed in Engine stop Switch in switch handle which are found in final inspection area now correction. These issues bring about expanding the expense of value to the business in wording changing over the non-adjustments to Good Product by arranging, revise and fixing process. The decrease pattern of PPM Level of monthswise is shown as appeared in Chart 5.1. The decrease in PPM level to roughly zero dimension diminished the expense of industry as pursues:

1) Tangible Benefits:

- ❖ Internal Rejection PPM reduced from 3717 PPM to "0"
- ❖ Cost Calculation
- ❖ Cost per part= 112.4 /-
- ❖ Average rejection/Month=364 No's
- ❖ Average cost saving/Month=40833/-
- ❖ Yearly cost saving= 4.9 lakhs

2) Intangible Benefits: Following benefits are found.

- ❖ Problem Solving Approach
- ❖ Confidence Level
- ❖ Communication
- ❖ Capability
- ❖ Team Work

There is a significant fall in PPM level from 3717 to 0 PPM.

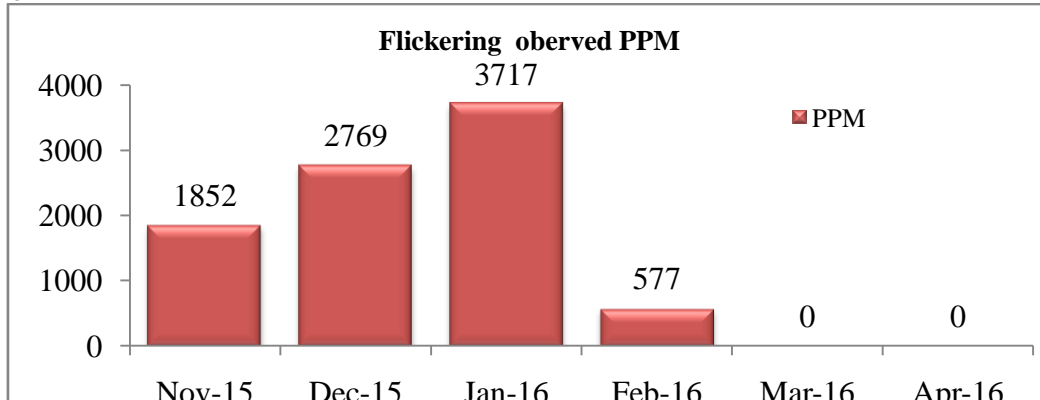


Chart 3 Reduction Trend of PPM Level by monthwise.

10.

Conclusions

In the present research work, an activity has been taken to apply Quality Circle Methodology in a small association assembling of automobile industry. The consequences of the examination demonstrated that Quality Circle Methodology engage representative to accomplish zero deformities in every potential ways and has a great deal of potential to pioneer quality framework. Organization saves a lot of money to eliminate rejection at in-house as well as at customer end. Problem solving methodology helps organization to eliminate rejection in a particular part and customer delightable. Implementation of problem solving methodology provides a positive effect in the organization and on employee. It boosts the morale of employee. In manufacturing industry, successful implementation usage of Quality Circle Methodology has been completed. In the present investigation, an endeavor has been made to execute Quality Circle Methodology in accomplishing zero imperfections underway in a small manufacturing industry. The results demonstrate that usage of Quality Circle Methodology execution has prompted a surprising benefit by lessening the expense of value by dispensing with the creation of not great items. This technique recorded end of 80% serious issue identified with item by fruitful and powerful execution of idea of Quality Circle among the representatives. This strategy improved work culture by giving chances to all representatives

progress in the direction of accomplishing target of industry. It gave stage to labor to give proposals in progress in concern zones. It found dependable and appropriate with respect to decrease the expense of preparing to new or existing workers by giving perpetual information that can be utilized in dreary way to comprehend preparing themes. It gave a thorough and adaptable framework for expanding business achievement.

11. Future Scope

In manufacturing industry at small scale, successful implementation of Quality Circle Methodology has been completed. Problem Solving Methodology can be applied to every industry to improve productivity and reduce / eliminate rejection and enhance customer satisfaction. It can be useful in Indian as well as in foreign Industries to cope with competitive world. It is a very good technique to reduce the amount of waste materials to the smallest level that is possible. This technique recorded eradication of serious issue identified with item by fruitful and compelling execution of idea of Quality Circle among the workers. This technique can be successfully applied to large scale industry to improve their quality and less wastage. Since this approach is related to team work, therefore it will goes towards the better development. That's why due to competitive age this technique can be applied successfully to the maximum industries.

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