Break down Analysis of Vertical Machining Center (VMC 900) in a Axle Housing Line by Root Cause Analysis

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Abstract: The manufacturing industries are facing a greater challenge in the market because of the various factors like standardization, quality etc. one of the ways to increase productivity is to increase the availability of the existing machines. This can be achieved by reducing the breakdowns of the machines. The VMC 900 performs various machining processes like grinding, milling and boring are carried out to on the axle housing component. When in final assembly the various components are assembled into the axle housing to have final product, lots of problems are faced. Problems like restricted movements of one component relative to other, torqueing of screws, failure of component in service etc. arise. So to avoid this, Root-Cause Analysis of these defects is carried out and the machine fixture unit is modified as per the results of analysis.

In this project, root cause analysis (RCA), was adopted to improve the machine availability & production capacity, MTBF to certain extent and reduce the downtime and MTTR of the machine and finally to prevent the failure of equipment before it actually occurs. Thus this project aims to minimize downtime, maximize availability, increase MTBF & decrease in MTTR. This present work concludes that this will help the PLE department to increase the machine availability & production capacity. Finally suggestions were given for future works.

Keywords—Axle Housing; Vertical machining center; clamping unit; Root Cause Analysis; MTTR; MTBF;

I. INTRODUCTION

The critical machine selected to conduct a project is vertical machining center (VMC 900) in the axle housing line of automotive axles limited. The vertical machining center is a CNC machine used for performing various machining process such as milling, boring tapping on the housing component of an Axle. This is done after the straightening operation of housing component and before the washing and inspection process respectively.

The vertical machining center (VMC 900) performs four major machining operations on the axle housing component. Initially the component is loaded on the fixture and the cycle is switched on. Automatically the end pusher moves the component to position and the levelling tool levels the component to the specified alignment required for machining. After that the clamping unit clamps the housing component in final position before the machining operations start.

Total Cycle time process is eleven minutes. So every eleven minutes one axle housing component undergoes complete machining operations and come out of the machine. Before the start of machining process the doors gets closed and all the operations are done in a closed environment. Here there is a frequent and repetitive breakdowns related to clamping unit. The most critical breakdown was frequent and repetitive stoppage of machine due to the component getting tilted during the machining process. Due to this problem the component gets rejected and machine availability is decreased.

Technically Swing Clamps should not be used when there are no fixed stops or hard locators into which the cutter force is transmitted. If Swing Clamps are oriented to hold vertically, horizontal
cutter forces should be transmitted into solid stops that can easily absorb their energy. If forces are transmitted to Swing Clamps at 90° to the clamp action, all the force is transmitted into the rotating mechanism. This may result in premature wear and early failure. In this present work the main aim was to eliminate the breakdown, increase the availability, MTBF and to decrease MTTR, to accomplish this the methodology adopted are Study of present problem, Data collection of breakdowns, Analysis of the data collected, Identify the breakdowns which are most critical, Finding the root causes of the breakdowns and Implement of counter measures.

II. ROOT CAUSE ANALYSIS

As the name itself tells, RCA is a method of analyzing a particular problem/breakdown considering the primary factors which are responsible for that problem/breakdown to occur. Root Cause is that, if corrected, would prevent recurrence of this and similar occurrences. The root cause does not apply to this occurrence only, but has generic implications to a broad group of possible occurrences, and it is the most fundamental aspect of the cause that can logically be identified and corrected. There may be a series of causes that can be identified, one leading to another. This series should be pursued until the fundamental, correctable cause has been identified. This method is considered to be the most reliable method of analysis in most of the industries. Many Root Cause Analysis Tools have emerged from the literature as generic standards for identifying root causes. Why-Why Analysis tool was used to determine the root cause in this project.

2.1 Purpose of a why-why analysis?

A why-why is a method of questioning that leads to the identification of the root cause of a problem. It is conducted to identify solutions to a problem that address it’s root cause. Rather than taking actions that are merely temporary, a why-why helps you identify how to really prevent the issue from happening again.

2.2 Root Cause Analysis & Implementation

2.2.1 Break down Description – Axle housing component rejection rate more.

Implemented area – Axle Housing line
Root cause – Original weak design
Physical phenomenon – Ineffective clamping unit

2.3 Root Cause from Why – Why Analysis

<table>
<thead>
<tr>
<th>Problem</th>
<th>Component rejection more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why?</td>
<td>Component gets tilted during the process</td>
</tr>
<tr>
<td>Why?</td>
<td>Top clamping pressure insufficient</td>
</tr>
<tr>
<td>Why?</td>
<td>Top clamp frequent failure</td>
</tr>
<tr>
<td>Why?</td>
<td>Stem breakage and key damage</td>
</tr>
<tr>
<td>Why?</td>
<td>Original Weak design</td>
</tr>
</tbody>
</table>

Table 2.1 Why-why analysis of chute rollers
2.4 Study of existing component:

**Figure 2.1 existing swing cylinder type clamping unit**

**Figure 2.2 worn out stem of the cylinder**

**Corrective action:** Top clamp modification
III. MODIFICATIONS

![Figure 3.1 before implementation of counter measure](image1)

![Figure 3.2 after Implementation of counter measure](image2)

Corrective action: The swing cylinder type clamping unit was replaced by the newly designed Top clamp unit. The design and assembly of the unit was done with the help of modelling software Solid works.
Benefits after implementations: The housing component is not tilting during the machining process as a result the problem of component being rejected is solved. The clamping unit related breakdowns are eliminated as a result of newly designed Top clamp unit.

IV. RESULTS AND IMPLEMENTATIONS

Table 4.1 Comparison of results before and after implementation of counter measures of VMC 900

<table>
<thead>
<tr>
<th>Availability before implementation</th>
<th>Availability after implementation</th>
<th>MTBF before implementation (Hours)</th>
<th>MTBF after implementation (Hours)</th>
<th>MTTR before implementation (Hours)</th>
<th>MTTR after implementation (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>94.04</td>
<td>97.61</td>
<td>58.68</td>
<td>96.90</td>
<td>3.71</td>
<td>2.36</td>
</tr>
</tbody>
</table>

Figure 4.1 Graph Showing Comparison of Availability before and after implementation of counter measures
V. CONCLUSION

The usage of root cause analysis (RCA) helped in determining the correct cause of failure by which suitable countermeasure are designed and implemented. The process Variables such as availability, MTBF and MTTR are calculated before and after the implementation of counter measures. as a result the following conclusions are drawn:

The faulty swing cylinder type clamping unit of the VMC 900 was replaced by the newly developed top clamp unit and the resulting breakdown due to clamping unit is completely eliminated

- The availability of the VMC 900 machine is increased from 94.04 to $97.61\%$.
- The MTBF of the VMC 900 machine is increased from 58.68 to $96.90$ hours.
• The MTTR of the VMC 900 machine is decreased from 3.71 to **2.36 hours**.

**REFERENCES**