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QUALITY ENHANCEMENT BY IMPLEMENTATION OF LAYERED PROCESS AUDIT IN ENGINE COMPONENT MANUFACTURING

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Abstract

Layered Process Audit plays very important role in the enhancement of operational performance of manufacturing industries. In today's global competition age, firms try to improve the operational performance, so as to get low production cost and better product quality with reduced lead-time and flexibility. This way a manufacturing organization can generate more profit with improved operational performance. For better improvement in operational performance, four major dimensions; cost, product quality, lead-time, and flexibility must be in appropriate proportion. This proportion may be different for different products and different manufacturing organizations. To achieve this appropriate proportion, Layered Process Audit can be adopted by the organization. The present research has undertaken "Implementation of Layered Process Audit in Engine Component Manufacturing" for quality improvement of product. Layered Process Audit is quality improvement process which involves multiple layers of management for auditing as well as quality improvement.

Keywords: *Quality, Layered Process Audit, Case Study*

1. INTRODUCTION

The need to enhance quality performance has been important issues because of competitive pressure in manufacturing company. In order to accomplish the higher aggressive level, all organizations must have the capacity to recognize the present quality performance, realism their techniques, operations and procedures to enhance the quality performance. Quality Healthcare and Education are provided by some of the 'forprofit' corporate style institutions in these areas (Sahu and Narkhede, 2019). Industry data demonstrate that the greater part of quality issues are caused by poor process control or by an inability to take after the proper procedure directions. Effective administration prepare capacity requires to recognizing the specific and common reason for the variation. Layered Process Audit is particularly effective in maintaining process enhancements and regulating key process steps since all levels of the association participate from administrators through to a senior manager. Senior manager frequently can learn much about from the operator, and operators can learn much about what is essential to the consumer from the manager. Many companies struggle with a lot of problem around such as communication, following standardized process steps, sustaining corrective actions, and customer satisfaction requirements to all level of the organization. Layered Process Audits reduce the deviation along the production line and up through the plant management. The concepts behind Layered Process Audits are not new. They find their origin the well-known Plan-Do-Check-Act continuous improvement cycle. Layered Process Audits require that multiple operational levels within a manufacturing facility review the same key operational controls (within the reviewer's span of authority) that ensure product quality. In Layered Process Audit first thing is develop effective Audit Plan in a better way and identified

processes and process steps requiring special attention due to their criticality to customer satisfaction rather than being a broad check of process compliance.

Auditing is the on-site verification activity, such as inspection or examination, of a process or quality system, to ensure compliance with requirements. According to ANSI/ASQC (1986) "Systematic examination of the acts and decisions by people with respect to quality in order to independently verify or evaluate and report the degree of compliance with operational requirements of the quality program, or the specifications or contract requirements of the product or service". According IEEE 1028 (1988) "An independent evaluation of software products or processes to ascertain compliance with standards, guidelines, specifications, and procedures based on objective criteria that include documents that specify the form or content of the products to be produced; the process by which the products shall be produced; and how compliance to standards or guidelines shall be measured". The Layered Process Audit (LPA) is a method that has been developed for improving the implementation of processes and specifications at all levels and in all area of the organization. It is an effective method that cultural change throughout an organization to enhance quality, reducing scrap, improving customer satisfaction and increasing the productivity of the organization. Here "layer" stand for involving a various level of management and "Process audit" stand for auditing the process which is used in manufacturing the product. A layered process audit is the most effective way to ensure processes consistently follow approved standards, reducing waste and rework, improving quality, and driving cultural change throughout an organization. For planning of layered process Audit, firstly require carefully plan with

the involvement of management by using multi disciplinary approach. Generally, five factors are used for planning of layered process Audit which is given below. Layered Process Audit is designed for detecting the nonconformance. In Reviewing the Layered Process Audit, always review the critical issue which affects the quality. Thus if Audit continues show great compliance, mean we have done that critical issue and focus on another critical area. Maintaining the Layered Process Audit is necessary for Audit. It includes those items which are critical for quality. It managing the Audit item in Layered Process Audit like adding or deleting the Audit item as required by the customer. It also adds some corrective action to Layered Process Audit if key steps or procedure are not following properly then adding some more process or procedure in Layer Process Audit.

2. LITERATURE REVIEW

Many researchers have worked on Layered Process Audit and analyzed it on different parameters. Here is a short summary of their work: According to Sittsamer and Leslie (2005), Layered Process Audits (LPA) is a strategy for quality improvement that is growing in popularity. When implemented well, LPA will improve First Time Quality (FTC), reduce waste, improve throughput and curb costs. Layered Process Audits can transform a company's culture to one which embraces continuous improvement. The value of LPA comes from holding the process to the norm, or desired behavior. Simply said, LPA redirects resources from reactionary efforts to prevention activities because it monitors the process, rather than the output. In a study carried out by Nexteer Automotive (2009) The purpose of this procedure is to define the process for performing and documenting layered audits. The purpose of performing layered audits is to a) verify compliance with the documented manufacturing/assembly process to assure the production system is working optimally, b) involve various levels of management in the audit process, c) remove roadblocks to correcting potential issues which are identified by the audit and d) lead to standardized work practices. According to Chrysler (2004), A Layered Process Audit is quality improvement process involving multiple layers of management. It consists of a regular schedule of all reviews of all elements in manufacturing/assembling process to ensure that equipment is being properly maintained; error proofing is working and work instruction being followed. Utilization of LPA will result in more disciplined process and improve overall quality. The Chrysler group is already using LPA. As reported by Kharkar and Kadam (2016), Layered process audits mean different layers of management will conduct audits at varying frequencies. This provides a system to verify compliance with the documented process, instill discipline, improve communication and improve overall quality. They are an industry standard and must be owned by manufacturing leadership. They are an industry standard & must be owned by manufacturing leadership. As per Askey and Dale, (1994), Audit is one of the many tools that have been found useful to identify the current quality performance by diagnosing the opportunities for improvement and plan for improvement

action. The audit is a tool with wide spread use throughout the business in the area of financial, quality, technical, safety, project management, human resources, and purchasing.

As reported by Shimada (2007), this paper described the characteristic of an audit system established for the development process and explained process improvement. This paper based on process development for implementing the audit. The implementation phase is conducted after the development of design phase. In the implementation phase, Audit team review all the data related to the development of the quality condition in each level of audit and correspondence change and add the new specification in the development plan. From the above literature review many researchers across the world have studied Layered Process Audit and its application is in various domains. During the literature study, it was observed that a) Layer Process Audit only includes process audit, not quality audit, b) varies according to manufacturing industry and does not follow a standard procedure based on the guideline, c) Layer Process Audit only includes Process/Procedure, not another parameter (like Design specification).

3. PROBLEM FORMULATION & RESEARCH OBJECTIVES

Industry data show most manufacturing quality issues are caused by poor process control often a failure to take corrective actions or a failure to follow the required process steps, as well as employees do not refer to instructions or procedures before taking every step of a process.

The major problem comes due to following reason based on process-

- Machine criticality has not defined, based on process.
- The Periodic corrective action is not taken for quality improvement.
- All Plant management is not involved as an auditor.

The following main objective of MAHLE has given below considering all aspect of product quality.

- To improve product quality by reducing errors, scrap and increase customer satisfaction.
- To improve inter- communication between plant management and operators.
- To publish what is important and what will be checked.
- To provide institutionalized training along with process knowledge for line operators and plant management.

4. RESEARCH METHODOLOGY

Layered Process Audit is particularly effective in maintaining process enhancements and regulating key process steps since all levels of the association participate from administrators through to a senior manager. Senior manager frequently can learn much about from the operator, and operators can learn much about what is essential to the consumer from the manager.

Many company struggles with many problem around 1) communication, 2) following standardized process steps, 3) sustaining corrective actions, and 4) customer satisfaction, and this requirements to all level of the organization. Layered Process Audits reduce the deviation along the production line and up through the plant management. After implementing the Layered Process Audit, address all these kind of issues.

The following key steps are used for conducting the Layered Process Audit.

- Layered process Audit items include past non-conformance, past customer return, and past customer complaint.
- Preparation of check sheet according past non-conformance.
- Layered process Audit is conducted according to a regular, planned and with specified audit frequency.
- Multiple levels of plant management are involved in audit the manufacturing process to the same questions.
- Audit results are recorded consistently, including corrective action, and are summarised for senior management review.
- Audit frequency depends on personal management level, not on availability.
- Nonconformance have predetermined reaction plan, which is implemented immediately.
- Audit question is updated as required to incorporate the latest improvements in system and processes based on audit finding, employee suggestion etc.

5. DATA COLLECTION

In order to evaluate the problem with the existing working methods and procedures and to implement the new and improved techniques, data corresponding to the existing work methods and data corresponding to the new improved technique are very important and useful. For implementing the Layered Process Audit following procedure has given below.

5.1 Designing of Layered Process Audit

Designing is the Process of making a plan for construction of an object. The object can be anything like management, Engineering, pottery, graphic design, business process and manufacturing process etc. For implementing the Layered Process Audit, Designing of Layered Process Audit consists following four factors which have given below.

- Layered Process Audit
- Audit layer, frequency, and Area of potential risk
- Check sheet
- Observation sheet

1.1.1 Layered Process Audit Plan

Layered Process Audits are effective only when they are

carefully planned. Using a multi-disciplinary approach, with management involvement, is the most effective way to plan for Layered Process Audits.

1.1.2 Audit Layer, Frequency, and Area of Potential Risk

In Designing of Layered Process Audit second factor are Audit layer, frequency, and Area of potential risk which depends on organization size.

1.1.3 Check Sheet

The check sheet is one of the basic tools of quality control tool. The check sheet is used for collecting the data on the instant of any process. In designing of Layered Process Audit, Preparing the check sheet is the third factor which involves what to Audit and who will be audit .For succeeding the layered process audit, Check sheet play a vital role in improving the process step and product quality.

1.1.4 Observation Sheet

In Designing of layered Process Audit fourth factor is observation sheet. Observation sheet is used for collecting the observation from check sheet and taking corrective action.

1.2 Data of Monthly Audit

Before Layered Process Audit, A Mini Process Audit was conducted for process audit. The following observation has taken from Mini Process Audit which has given in Table 1.

After conducting the Layered Process Audit, The following observation has taken form Layered Process audit in trial phase which has given in Table 2.

| Process Name | Observation | |
|---------------------|-------------------|------------------------|
| | Total observation | Compliance observation |
| Facing & Centering | 45 | 28 |
| Turning | 50 | 35 |
| Number punching | 10 | 7 |
| VMC Machining | 25 | 18 |
| HMC Machining | 25 | 17 |
| Journal Grinding | 38 | 28 |
| Cam Grinding | 50 | 38 |
| Keyway milling | 34 | 24 |
| Crack Testing | 4 | 3 |
| Lapping | 15 | 10 |
| Washing | 9 | 7 |
| Phosphating | 3 | 2 |
| Induction Hardening | 11 | 7 |
| Child Part Assembly | 9 | 6 |
| Oiling & Packing | 10 | 8 |
| Final Inspection | 12 | 12 |

Table 2. Data of monthly audit of layered processes audit

| Process Name | Observation | |
|--------------------|-------------------|------------------------|
| | Total observation | Compliance observation |
| Facing & Centering | 50 | 40 |
| Turning | 50 | 40 |
| Number punching | 10 | 8 |
| VMC Machining | 22 | 18 |
| HMC Machining | 25 | 20 |
| Journal Grinding | 30 | 24 |
| Cam Grinding | 40 | 32 |
| Keyway milling | 30 | 24 |
| Crack Testing | 3 | 3 |
| Lapping | 14 | 11 |
| Washing | 10 | 8 |
| Phosphating | 3 | 3 |

| | | |
|---------------------|----|----|
| Induction Hardening | 10 | 8 |
| ChildPart Assembly | 10 | 7 |
| Oiling & Packing | 10 | 8 |
| Final Inspection | 11 | 11 |

1.3 Data Analysis

Data Analysis is an important part of implementing the new procedure or method instead existing procedure or method. For analyzing the data, Microsoft Excel has used. Microsoft Excel is software for mathematical calculations of data. It is used widely for the management of numeric data. Many mathematical calculations like mean, median, mode, correlation coefficient etc. can be calculated by using this software. It can also be used to create charts and plots of different type as suitable to the researcher.

Comparative analysis of compliance status of all process in Layered Process Audit and Mini Process Audit.

Fig.1 Compliance status of all process in Mini Process Audit in Dec-2016

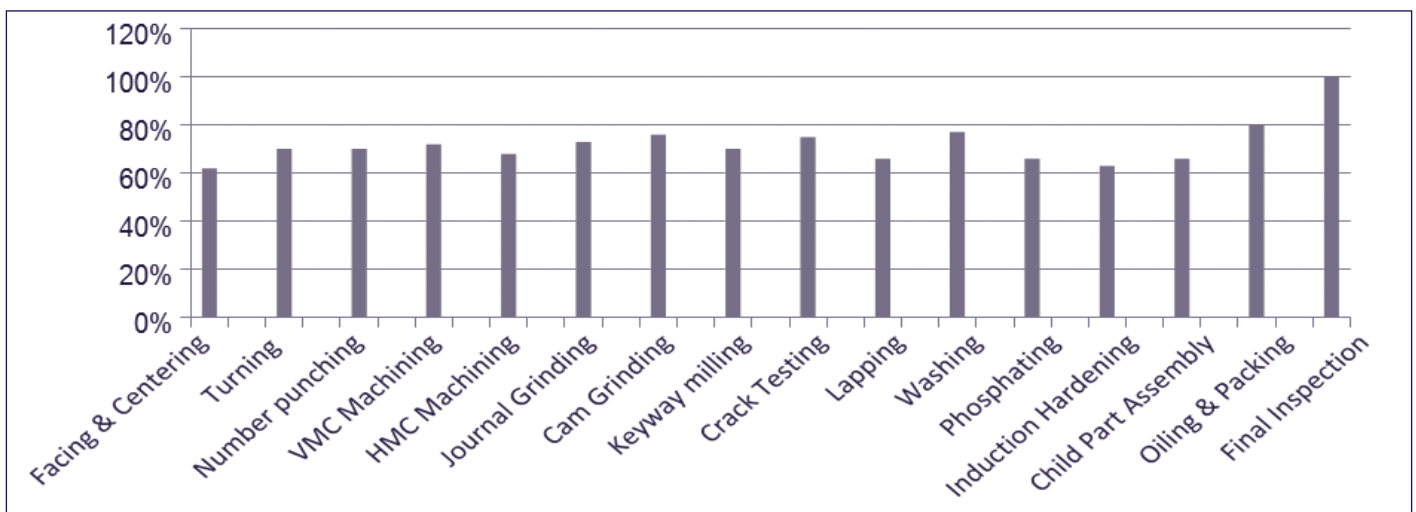
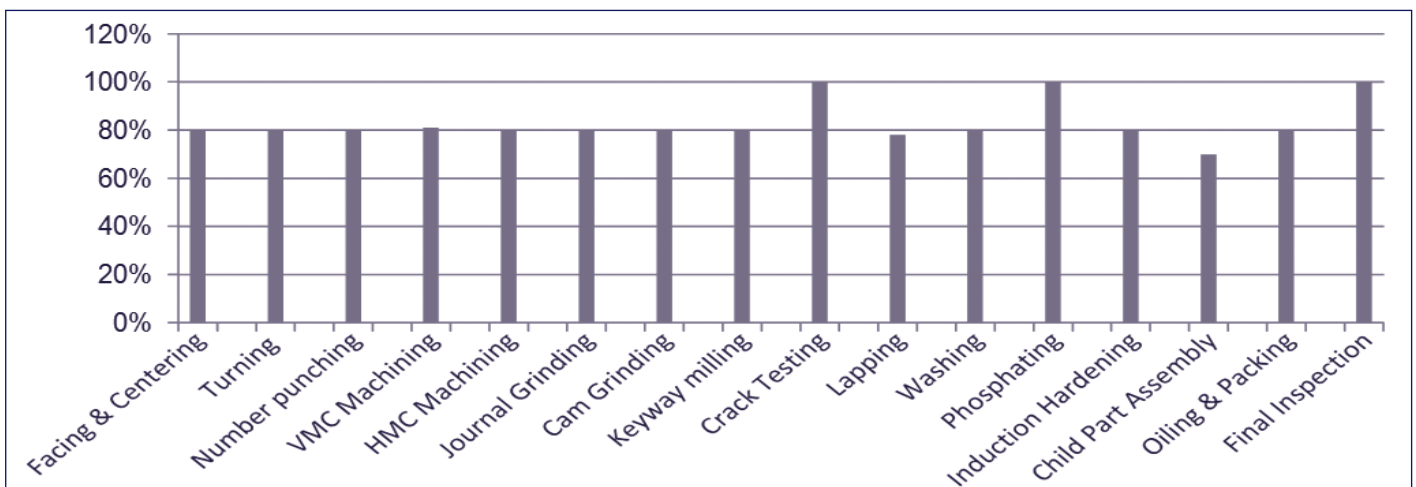


Fig.2 Compliance status of all process in Layered Process Audit in Jan and Feb-2017



6. RESULT AND DISCUSSIONS

After implementing the Layered Process Audit, many critical issues have gone resolve which was related from Part/Product, Process, Facility, and Voice of customer in the manufacturing process because all Plant management involves as an auditor. The some area where improvement has been seen which are related from a process like control Plan and standard operating process(SOP) are updating frequently, inspection gauges have identified wherever required, which impact on product quality. Apart from this issue, has also improved where organization struggle with issues around

- Communication
- Consistent compliance with standardized process steps
- Sustaining and institutionalizing corrective action

7. CONCLUSION

Layered Process Audit is quality improvement process which involves multiple layers of management for auditing as well as quality improvement. In Layered Process Audit first thing is to develop effective Audit Plan in a better way and to identify processes and process steps, requiring special attention due to their criticality to customer satisfaction rather than being a broad check of process compliance. In Layered Process Audit, Audit layer and Audit frequency should be according to organization size for effective result. Management should review Audit result and monitor the impact of Audit on process improvement as well as quality improvement. Finally maintaining the Audit item's which are critical for a process whereby will reduce critical items and quality of the product will be improved. The some area where improvement has been seen after implementing the Layer Process Audit which are related from a process like control Plan and standard operating process(SOP) are updating frequently, inspection gauges have identified wherever required, whereby reduce in error, scrap and improve product quality. The Compliance status of observation has been increased from 71% to 80% after implementing the Layered Process Audit. Thus reduced critical issue and improved product quality. After implementing the Layered Process Audit has also improved communication between plant management and operators because all level of plant management involve as an auditor.

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