

Application of FMEA Method in a Manufacturing Organization Focused on Quality

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Abstract- Failure Modes and Effects Analysis (FMEA) is a tool widely used in the automotive, aerospace, and electronics industries to identify, prioritize, and eliminate known potential failures, problems, and errors from system under design before the product are released. Document the process. FMEA can be used as an individual project tool. However, it is strongly recommended that use to generate corrective action in a process improvement project. In this study, Case study is conducted and FMEA technique is applied to the cylinder head manufacturing process industry. Criteria for ranking of severity occurrence and detection are selected suitably by analyzing the past failure records of the machine. Firstly, the basic requirements of the manufacturing processes are studied and then the potential failure mode of the specific process is found out.

Keywords- Failure Modes and Effects Analysis (FMEA), Case study, cylinder head, manufacturing process industrv. severity. occurrence. detection.

I. INTRODUCTION

Failure Modes and Effects Analysis (FMEA) is a tool widely used in the automotive, aerospace, and electronics industries to identify, prioritize, and eliminate known potential failures, problems, and errors from system under design before the product is released.

FMEA proves to be one of the most important early preventive actions in system, design, process, or service which will prevent failure and errors from occurring and reaching customer.

FMEA's are conducted in the product design or process development stages, although conducting an FMEA on existing products or processes may also yield benefits. A failure mode is defined as the manner in which component, sub system, system, process etc, could potentially fail to meet the design intent.

FMEA used to solve problems due to manufacturing process. FMEA method is used to calculate RPN for each failure mode and then proposed recommended actions to reduce the RPN.

1. Quality management systems and other management system focuses:

"The quality management system is that part of the organization's management system that focuses on the achievement of results, in relation to the quality objectives, to satisfy the needs, expectations and requirements of interested parties, as appropriate.

The quality objectives complement other objectives of the organization such as those related to growth, funding, profitability, the environment and occupational health and safety. The various parts of an organization's management system might be integrated, together with the quality management system, into a single management system using common elements.

This can facilitate planning, allocation of resources, definition of complementary objectives and evaluation of the overall effectiveness of the organization.

The organization's management system can be assessed against the organization's management system requirements. The management system can also be audited against the requirements of International Standards such as ISO 9001 and ISO

14001. These management system audits can be carried out separately or in combination”.

2. Self-Assessment:

“An organization's self-assessment is a comprehensive and systematic review of the organization's activities and results referenced against the quality management system or a model of excellence. Self-assessment can provide an overall view of the performance of the organization and the degree of maturity of the quality management system. It can also help to identify areas requiring improvement in the organization and to determine priorities”.

II. LITERATURE REVIEW

The FMEA technique was first reported in 1920's but its use has only been significantly documented since the early 1960's [1]. FMEA was developed by Grumman aircraft cooperation in 1950 and 1960's and it was first applied to the naval aircraft control system at Grumman [2].

Rimawan et al. (2019) presented the failure modes that cause product defects by using the FMEA method, getting the risk of the biggest production process failure in the value of the RPN (Risk Priority Number), providing proposed improvements for subsequent production. Based on processing with the FMEA method can identify modes of failure that occur in the process making drugs. The mode of potential failure in the process of making drugs consists of 6 types of failures.

Ostadi et al. (2019) presented failure modes and effects analysis (FMEA) technique has been utilized to find errors and their causes in the production line of the Iranian Tobacco Company. With the completion of FMEA table and calculating Risk Priority Number (RPN) values, all errors were zoned and prioritized. The prioritization of the discovered errors based on FMEA technique indicated human error as the most important factor in the emergence of errors.

Górkaet al. (2019) presented the key issues related to quality management: starting with defining the concept of quality, its essence and the method of its management. In addition, the perception of the quality of both the consumer and the manufacturer,

as well as the impact of quality on the life cycle of the product.

Cupşan et al. (2019) presented the current state of risk management in the knowledge-based organizations and the importance of a preventive approach, with emphasis on the aerospace and defence industry, as well as gives detailed information on the Failure Mode and Effects Analysis (FMEA) method, in its current known state.

Oliveira et al. (2019) presented the excess of failures in a mobile phone line production in order to make process improvements in a factory of the industrial pole of Manaus (PIM) by using FMEA methodology (Failure Mode, effect analysis).

The excess of failures was an extremely influential aggravating factor by its customer, since the increase of the productive capacity in the company would be determined by the reduction of the percentage of failures or increase of YIELD from the conception of the product until the final phase of its life.

Tao et al. (2019) presented A risk assessment was conducted on select processes from the overall manufacturing of LFIAs available at Company X.

The focus of the potential failure modes was restricted to processes and methods used to produce components for the LFIA. The modes were recorded on the FMEA table to assess the estimated risk using the severity and probability rating set by Company X.

Cagnin et al. (2019) presented a case-based research was adopted at an automotive company. The research results indicated that risk management approach is part of the culture at the analyzed company and is already being addressed in some of the organization's processes, among which are the product development process, supply chain management, and machine and equipment management.

Fajrah et al. (2019) presented the application of the quality management system of the crumb rubber industry to the ISO 9001: 2015 certification standard. The analysis was carried out on case studies and discussions with leaders of crumb rubber companies in Padang City. The success of the implementation is affected by indicators that influencing in ISO 9001: 2015 certification standards.

Altuntas et al. (2019) presented an innovative and integrated approach based on service quality measurement (SERVQUAL), quality function deployment (QFD) and failure modes and effects analysis (FMEA) for service quality improvement.

Rimawan et al. (2018) presented the Six Sigma method which aims to identify all types of defects in herbicide products, This study uses the Six Sigma method which aims to identify CTQ (critical to quality) in the production process, Measuring DPMO, Level Six Sigma, After that analyzing the causes of defects using fishbone which consists of machine, material, method, human factors, then making proposed improvements by doing FMEA analysis, the company is expected to be able to find out the cause of disability companies and be able to take better corrective actions.

Bebr et al. (2018) presented the product requirements are ever increasing. From this fact the perpetually heightening demand on processes and their quality ensues. Many tools are used for statistical process control and analysis of the causes and consequences is one of these.

Doshi et al. (2017) presented the contribution of FMEA to achieve Continuous Quality Improvement (CQI) by multiple case study research. The outcome research conducted by implementing FMEA; one of the Auto Core Tools (ACTs), in the automobile Small and Medium Enterprises (SMEs) in Gujarat, India is presented in this paper which depict various means of Continuous Quality Improvements.

III. CASE STUDY AND FMEA ANALYSIS

In the vast majority of four stroke engines, the cylinder head mounts the entire valve gear and provides the basic framework for housing the valves as well as the spark plugs and injectors.

Case study is conducted and FMEA technique is applied to the cylinder head manufacturing process industry. There are various operation and processes carried out by various machine for manufacturing cylinder head. Facing, drilling and tapping are the main manufacturing operations of the cylinder head.

Following manufacturing operations are carried out on the cylinder head:

- Bottom Face Finish

- Top Face Finish
- Inlet & Exhaust face finish
- Front & rear side face finish
- Topside
- Bottom Side
- Inlet & Exhaust face Drilling
- Water Outlet Face Drilling
- Core Plug Drilling
- Injector Bore etc.

Criteria for ranking of severity occurrence and detection are selected suitably by analyzing the past failure records of the machine. Firstly, the basic requirements of the manufacturing processes are studied and then the potential failure mode of the specific process is found out. After that the potential effects of the failure mode are noted with their severity value. The occurrence value for the potential causes and their prevention is also calculated.

The Detection value is assigned to the failure mode and finally the R.P.N value is calculated.

The sample calculations are

$$\text{If } S = 4, O = 3, \& D = 4$$

Then,

$$R.P.N = S \times O \times D = 4 \times 3 \times 4 = 48$$

The potential failure mode according to RPN-Prevention is determined through semi-structured interviews and the results are listed on the FMEA analysis worksheet as illustrated in Table 5. Tool rating has been selected as process failure frequently happened due to the lack of hand tools provided during dismantling.

In order to prevent this failure, it is necessary to give skills training to employees on the shop floor, so that they acquire the necessary capabilities and can effectively use the hand tools given. The worker will develop skills on the usage of these hand tools and be aware of risks in the event the tools are misused.

Therefore, the company should always ensure that the quantity of hand tools is sufficient and each shop floor personnel be made responsible for using and keeping the hand tools in a safe manner. The lack of special tools or equipment will result in slow dismantle rates and will adversely affect the company's reputation in the long run.

IV. CONCLUSION

FMEA provides a discipline/methodology for documenting this analysis for future use and continuous process improvement. It is a systematic approach to the analysis, definition, estimation, and evaluation of risks.

Following a standard setup procedure will reduce setup time and improve part accuracy thereby increasing the quality and efficiency of processes. Many measures like standard operating procedures, Master piece of Correct Depth is Provide for Setting, in process inspection, process drawing, and first piece inspection.

FMEA analysis may easily help in improving the efficiency of the manufacturing process and quality of product thus decreasing the number of defective products and saving of rework cost and time.

For each specific process the preventions suggested in the table can considerably decrease the loss to the manufacturing industry in terms of both money and time.

REFERENCES

- [1] "Failure mode and effect analysis (FMEA)", Total quality management- university of Michigan. A Wadhesh Kumar, M. P. Poonia (Jun 2011) "FMEA: Methodology, design and implementation" international journal of engineering science and technology, volume 3, no.6.
- [2] Rimawan, Erry, Apriliana Cendraleka, Johan Permana, and Dydi Purwanto. "Application of FMEA for Identifying Risk Failure of the Medicine Failure Process."
- [3] Ostadi, Bakhtiar, and Mehrdad Saboory Masouleh. "Application of FEMA and RPN techniques for man-machine analysis in Tobacco Company." Cogent Engineering 6, no. 1 (2019): 1640101.
- [4] Górka, M., B. Ślusarczyk, A. Woźniak, J. Baran, and E. Brągiel. "Selected issues concerning quality management in the company." (2019).
- [5] Cupșan, Vlad Ciprian, Mihail Aurel Țițu, and Gheorghe Ioan Pop. "Enhancements to Failure Mode and Effects Analysis (FMEA) Method, Aiming to Improve Risk Management in the Knowledge-Based Organizations." In International conference Knowledge-Based Organization, vol. 25, no. 1, pp. 206-212. Sciendo, 2019.
- [6] Oliveira, Marcelo, Samuel Batista, Dercio Reis, Gabriela Veroneze, and Raissa Maciel. "Application of FMEA for Improvement in the Manufacturing Process of Mobile Phones in a Factory of the Industrial Pole of Manaus." International Journal for Quality Research 13, no. 4 (2019).
- [7] Tao, Diana. "Using Failure Mode and Effects Analysis (FMEA) to Analyze the Manufacturing Process of Rapid Lateral Flow Immunoassays." (2019).
- [8] Cagnin, Fernanda, Maria Celia de Oliveira, and Paulo Augusto Cauchick Miguel. "Assessment of ISO 9001: 2015 implementation: focus on risk management approach requirements compliance in an automotive company." Total Quality Management & Business Excellence (2019): 1-19.
- [9] Fajrah, Nofriani, Nilda Tri Putri, and ElitaAmrina. "Analysis of the application of quality management systems in the rubber industry based on ISO 9001: 2015." In IOP Conference Series: Materials Science and Engineering, vol. 602, no. 1, p. 012039. IOP Publishing, 2019.
- [10] Altuntas, Serkan, and Semih Kansu. "An innovative and integrated approach based on SERVQUAL, QFD and FMEA for service quality improvement." Kybernetes (2019).
- [11] Rimawan, Erry, and Angga Pratama. "Improvement of Quality Control of Herbicide Products using the DMAIC Method Case Study in Chemical Companies in Merak-Banten." International Journal of Innovative Science and Research Technology 3, no. 12 (2018): 84-98.
- [12] Bebr, Lukáš, and KateřinaBíčová. "SPC in Joint Application with FMEA." (2018).
- [13] Doshi, Jigar, and Darshak Desai. "Application of Failure Mode & Effect Analysis (FMEA) For Continuous Quality Improvement-Multiple Case Studies in Automobile SMES." International Journal for Quality Research 11, no. 2 (2017).