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The reduction of failures in plastic product by the use of "FMEA"

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ABSTRACT

In this current time of globalization and privatization, manufacturing firms are greatly relying upon the concept of failure mode effective analysis to fight with challenges of current market trends. This paper help to perceive and overcome the irregularities in plastic product by apply application of "FMEA". It is focused on preventing problems, enhancing safety, and rising customer satisfaction. Due to implementation of FMEA can get larger benefits, such as improving product quality, reliability, and security, enhancing company's image and competitiveness, satisfying customer requirements, etc.

1. INTRODUCTION

In the field of manufacturing and service activities, issues such as the intensity of competition, rising customer expectations, and increasing developments in the technology lead to increase the manufacturers' obligations towards correcting defects and deviations in product performance. The plastic processing industry is one of the industries that the failure rate is high in them. Most failures in this industry cause harm human and non-human factors. Thus, detecting failures in this type of industries are of utmost importance. Proper planning to identify and control these failures by the management of manufacturing enterprises in the plastic processing industry leads to the production of high-quality products and according to the global standards to compete in the world markets. Therefore, the tools must be used to identify these failures to achieve high-quality product and without any failure. One of the practical methods available is a tool called failure mode and effect analysis (FMEA) which is used to ensure that the product is perfect and can compete with other products on the market. The well known failure mode and effects analysis (FMEA) approach represents an absolute quality tool that is typically applied at the design stage for both product and services.

2. FMEA

FMEA is a procedure in operations management for analysis of potential failure modes within an approach for assessment by severity or find the effect of failures on the system. The FMEA action is well developed and documented in the military handbook and as a military standard. There are two phases in the FMEA process. The first phase is to find out the potential failure modes and their effects. The second phase is to achieve criticality analyses to determine the severity of the failure modes. The first phase has to be done all together with the absolute product design. It should also include defining the possible failures of the product's components, sub-assemblies, final assembly, and its manufacturing processes. At the end of the first phase, the detailed design is completed, and the design drawing is developed. At the second phase of FMEA, engineers in the FMEA team ascertain and rank the criticality of each failure, and then revise each design detail and make required modifications. The most serious failure has the highest rank and is considered first in the design revision. The design is revised to ensure that the probability of occurrence of the highest ranked failure is minimized. It provides a framework for cause and effect analysis of absolute product failures. Each failure mode will be assessed in three parameters, namely, severity, occurrence, and difficulty of detection of the failure mode. A typical evaluation system gives a number between 1 and 10 (with 1 being the best and 10 being the worst case) for each of the three parameters. By multiplying the values for severity (S), occurrence (O), and detect ability (D), it obtains a risk priority number (RPN), which is RPN = S X O X D (multiplication of severity, occurrence and detection).

3. REVIEW OF RESEARCH

Bouti and Kadi et al (1994) investigated that the FMEA documented single failures of a system, by identifying the failure modes, and the causes and effects of each potential failure mode on system service and defining appropriate detection procedures and corrective actions. When extended by Criticality Analysis procedure (CA) for failure modes classification, it was known as Failure Mode Effects and Criticality Analysis (FMECA).

Shivani Sharma1 and Ravindra Pratap et al. (2013) proposed a comparative design of various risks factors reduces the chance of its occurrence. It indicates that validity of many of the measurement frameworks need to be established through study. This process of choosing appropriate supply chain performance measures is difficult as a result of the complexity of these systems.

Ettore De Francesco, Ruggero De, Fabio Leccese and Anna Paggi et al. (2014) proposed that aims to the integration of an expanded FMEA analysis, supported by the S3000L database structure, with the "in field" avionic measurements. This should lead to the reduction of the times and costs involved into failure identification and resolution and should allow the "qualification" of the operator "sensations" and "experiences" for the identification of failures in a complex avionic system.

Sourabh Rana and, Dr. R.M.Belokar et al. (2017) proposed that implementation of Process Failure mode and effect analysis for improvement in welding process through betterment in various sub-processes. Considered various measurements and identify them. The calculation is discussed along with their rankings. Severity, Occurrence and Detection are detected to calculate the Risk Priority Number (RPN).

Elanur Adar, Mahir and ˙Ince, Buket Karatop, et al (2017) proposed that study is to identify the problems that occur during the operation of a continuously operated, laboratory-scale supercritical water gasification system and to identify their reasons and effects. For this purpose, cause-and-effect diagram, classical failure mode and effect analysis and fuzzy failure mode and effects analysis were carried out. As a result of the analyses performed, it has been concluded that the most important problems are plugging, corrosion, reactor design and incompatible material selection.

Ru-xin Nie, Zhang-peng Tian, Xiao-kang Wang ,Jian-qiang Wang, and Tie-li Wang et al.(2018) proposed that The sustainability challenge is increasingly driving the adoption of supercritical water gasification (SCWG) technology to ensure the elimination and recovery of pollution produced by sewage sludge treatment (SST). Risk evaluation by failure mode and effects analysis (FMEA) plays a crucial role in guaranteeing the reliability and safety of SCWG systems. However, some limitations in existing FMEA methods need to be ameliorated.

4. RESEARCH OBJECTIVES

The following objectives of our research are to be set.

1- Identify the RPN for FMEA from an exhaustive review.
2- Know the effectiveness of RPN for FMEA.
3- Impact of RPN on the measure of performance.
4- Provide some of the findings recommendations.

5. RESEARCH METHODOLOGY

Blow moulding consists of a forced blowing of a resin (e.g. HDPE) contained inside a hopper through an extruder toward a parison in the shape of a mould cavity. The parison is in turn contained in a female mould that reproduces the outer shape of the product to be gained. The bottom of the product is formed by closing the moulds, the top is formed by an extrusion die head. In order to facilitate the molding of the plastic, the resin is brought to high temperatures and then cooled either by blowing air into the parison or by using a water-cooled mould. The technological configurations of blow moulding machines are enlarge in respect of several factors, for instance the type of resin, the productivity to achieve, the shape of the product, and so on.. A mixer is installed in order to supply all the lines with their specific resins. As note, the conformity of final products to quality standards in the blow moulding process may be simply monitored by inline operators. Visual inspections and manual tests (e.g. weighing) are sufficient for the vast majority of potential defects. The Quality Department receives reports from the production lines. As a result, reliable data concerning the number and kind of defects detected (i.e. failures) is available on a regular basis. Otherwise, detecting the link between failures and their causes would be a complex process, requiring in-depth knowledge of the field. In fact, inline operators are not familiar with FMEA, the technological process or maintenance policies. On the other hand, the impression given by interviews with quality managers is that they What is the degree up to which various factors FMEA are being followed in Indian small and medium scale plastic chair moulding industry. Nearby Bhopal .In this industry satisfies with RPN calculation while implementing FMEA .In plastic chair moulding industry. Feel confident linking the failures directly to maintenance interventions.

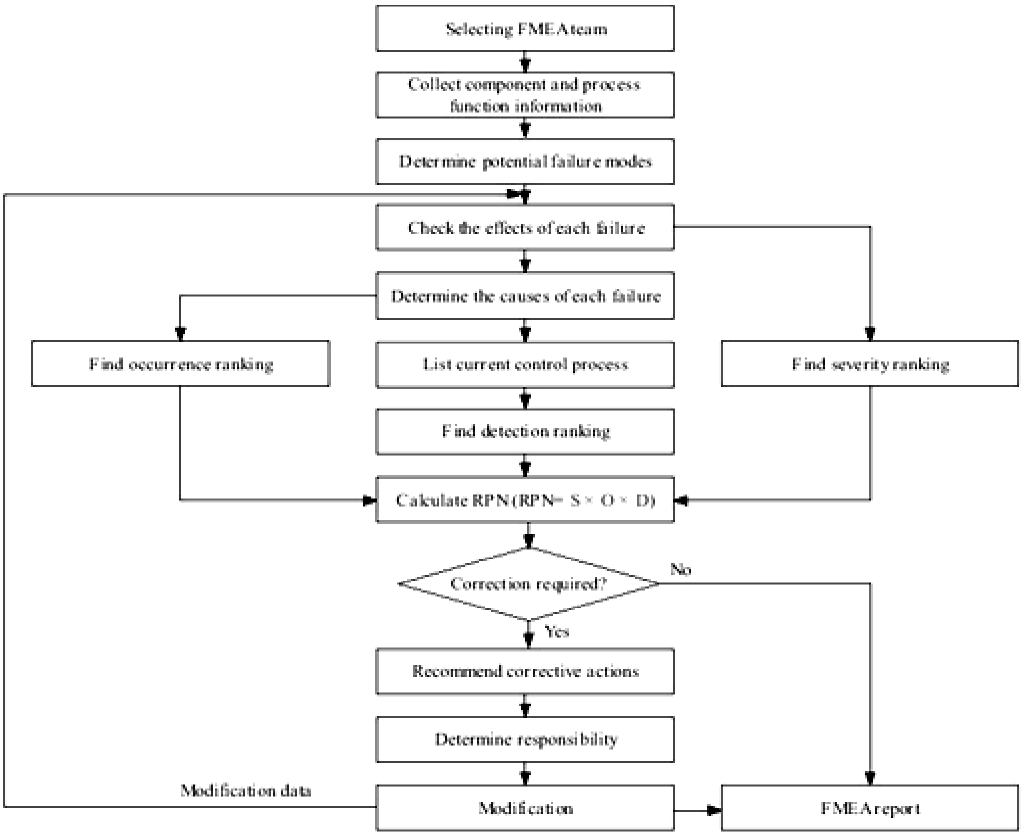

Figure 1. FMEA Procedures.

The approach adopted in this study included a review of the literature, as it was deemed important to understand the concepts and methods involved (Gil, 2002). Because the aim of the study was to identify irregularities in the way that FMEAs were filled out, a case study involving a plastic chair manufacturer.

Step1: Failures are recorded during a pre-defined time horizon.

Step 2: RPN_ is calculated for all the failures.

Step 3: Calculate new RPN with new changes.

Step 4: Compare new and old RPN for desired result.

Step 5 Analysis of result.

5.1 FMEA CONTENT'S

1. SEVERITY(S)-: It measures the seriousness of the effect of a failure mode. Measuring scale is between 1 to 10 variables. ()

2. Probability of occurrence (O)-: it is related with the failure of the failure mode and causes.

3Detection (D)-: it measures quality control testing programs design review from the company.

4 Risk priority number (RPN)-: The risk priority number is the product of the severity (S), Occurrence (O) and Detection (D) ranking. it measure of design risk and will compute between "1 and 1000"

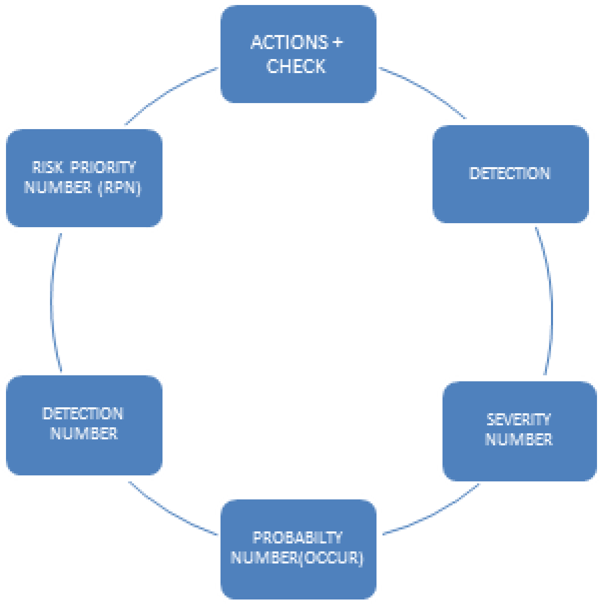

Figure 2. Circular diagram of FMEA

5.2 DATA COLLECTION

Data collection process ensures that what data collected and it's good or bad for further process. First have to understand knowledge of the process according to block diagram chart. Performs rejection data, information about performs, from machines from the production plant.

Table 1.

Sr no	Problem detection	Rejection%
1	Bubble formation	35
2	Weak bottom of chair	27
3	Excess plastic outside the chair	20
4	Weak handles	17
5	High weight of chair	10

In above table shows the problem identify, in selected company where bubble produce inside in product by material cause, we got 35% rejection in all tests. weak bottom of chair is a problem identify in process rejection is 27%,Excess plastic on outside of chair which made by temperature increase in moulding machine was found 20%,weak handles of chair and high weight of chair % rejection is low in research process is all about 17,and 10%.

Injection moulding process consists of a forced blowing of a resin (HDPE) contained inside a hopper through an extruder facing a parison in the shape of a adapt cavity. The parison is in turn contained in a female mould that reproduces the outer shape of the product to be gained. The bottom of the product is formed by closing the moulds; the top is formed by an extrusion die head. By stages to act for moulding of the plastic, the resin is brought to high temperatures and then cooled ascertain by blowing air into the parison or by using a water-cooled mould. The technological configurations of injection moulding machines are enlarge in respect of several factors, for instance the type of resin, the productivity to achieve, the shape of the product, and so on.. A mixer is installed in order to supply all the lines with their specific resins. As note, the conformity of final products to quality standards in the injection moulding process may be simply monitored by inline operators. Apparently inspections and manual tests are sufficient for the vast majority of potential defects. The Quality Department receives reports from the production lines. As a result accurate data about the number and a bit defects detected is available on a regular basis. Otherwise, detecting the link between failures and their causes would be a complex process, requiring in-depth knowledge of the field. In fact, inline operators are not familiar with FMEA, the technological process or maintenance policies. On the other hand, the impression given by interviews with quality managers is that they what is the degree up to which various factors FMEA are being followed in Indian small and medium scale plastic chair moulding industry

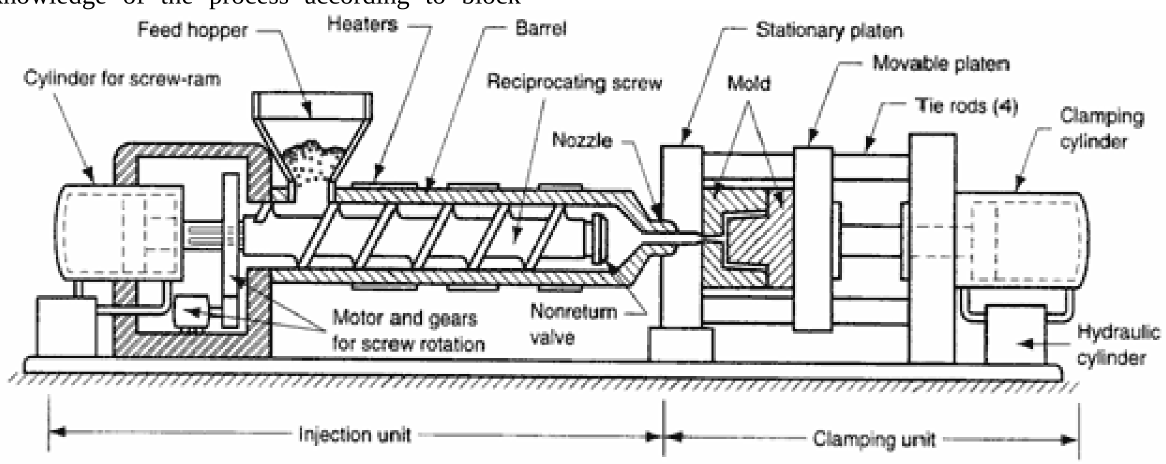

Figure 3. Injection moulding machine

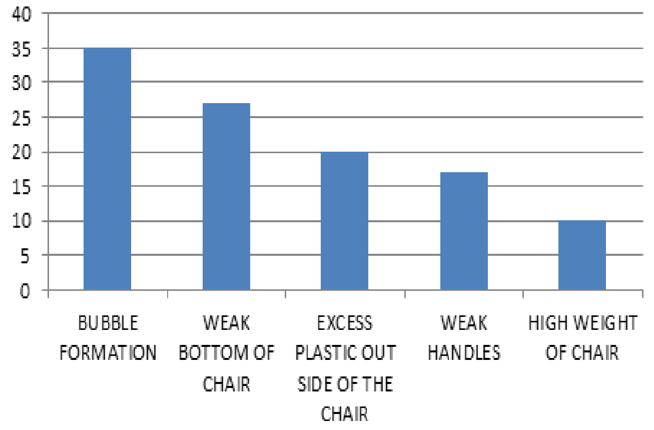

Figure. 4 Chart for percentage rejection

The above graph and table shows the rejection of plastic chair in various ways, in selected company According to FMEA we overcome these defects.

5.3 ANALYSIS OF DATA

After rejection data is collected analysis of data is important tool to overcome this rejection. Accordingly efforts have been put to reduce the rejection. First of all data to identify causes of occurrence of each problem and effects of these problems on quality characteristics.Once problem and rejection identify it moved the operative phase of risk evaluation thorough FMEA form. These potential causes' failure effects that finds failure, evaluation of three risk parameters and calculation of RPN of each cause and problem.

It is a numerical scale are listed below by table form, it is based on high pressure molding line of the company product.

RPN steps are as follows

1 Occurrence

2 Severity

3 Detection

RPN = Occurrence X Severity X Detection

5.4 OCCURRENCE CRITERIA

The probability that a failure will occur during the expected life of the system can be described in potential occurrences per unit time.

Table 2. FMEA Occurrence criteria

Probability of failure	Possible failure rates	Ranking
Very high- Almost inevitable	100/1000	10
	50/1000	9
High Repeated failure	20/1000	8
	10/1000	7
Moderate occasional failure	5/10000	6
	2/10000	5
Low relative few failure	1/1000	4
	.5/1000	3
	.1/1000	2
Remote Failure is unlikely	.01/1000	1

These failures rate criteria are taken in research process in selected company in 20 days trail production of plastic chair. Where many probability failure are found and it lies between 10 to 1 ranking.

5.5 SEVERITY RANKING CRITERIA

Severity is a numerical subjective estimate of how severe the customer (next user) or end user will perceive the effect of a failure. In table Severity Ranking Criteria shows the customer satisfaction which effects come under the category of severity ranking 10 to 1.

Table 3. Severity Ranking Criteria.

Effect	Criteria –Severity of effects	Ranking
Hazardous	Maximum hazardous effect	10
Extreme	Some failure with hazardous effect	9
Very high	Inoperable with loss of primary function	8
High	Very poor performance customer dissatisfied	7
Moderate	Customer experience discomfort	6
Low	Operable but customer dissatisfaction experience	5
Very low	Defect notice by most customer	4
Minor	Defects notice by average customer	3
Very minor	Defects notice by discriminating customer	2
None	No effect	1

5.7 DETECTION CRITERIA

Detection is sometimes termed effectiveness. It is a numerical subjective estimate of the effectiveness of the controls to prevent or detect the cause or failure mode before the failure reaches the customer.The assumption is that the cause has occurred value.

Table 4. Detection criteria table

Detection	Criteria	Rank
Absolute uncertainty	Unproven, unreliable chance for detection	10
Very Remote	Very remote chance is operation controls have poor chance of detection	9
Remote	Remote chance operation controls are likely to miss the problem	8
Very low	Operation controls may miss the problem	7
Low	Operation controls have an even chance of working.	6
Moderate	Operational controls are moderately effective.	5
Moderately high	Likely to be moderately high probability of detection	4
High	High chance of operational controls	3
Very high	Very high chance of probability of detection	2
Almost certain	Controls will almost certainly detected	1

6 RESULTS ANALYSIS

6.1 RPN CALCULATION

Table 5. Calculation of RPN table

Sr no	Problem description	Cause	S	O	D	RPN
1	Bubble	Variation in drier temperature	7	9	3	189
2	Weak bottom of chair	Injection speed	7	9	2	126
3	Excess plastic outside the chair	Barrel temperature	7	7	4	196
4	Weak handles	Screw speed	4	5	4	80
5	High weight of chair	Material degradation	8	7	4	224

RPN Calculation is multiplication of, Severity X Occurrence X Detection in table. These ranking perform in research process at selected company. Severity, occurrence, and detection ranking have their means in above tables.

6.2 DATA INTERPRETATION

Data interpretation used to find the significant factors for potential Failures.

Barrel Temperature, Drier Temperature, Injection Speed and Screw Speed. So these factors are significant concerns with defects .Material degradation, Bubbles, weak bottom of chair, excess plastic outside the chair weak handles and high weight of chair respectively.

Table 6. Factors of product

Defects	Factors	Value	Significant/no significant
Bubble formation	Variation in drier temperature	240°C	Significant
Weak bottom of chair	Injection speed	260 MM/SEC	Significant
Excess plastic outside the chair	Barrel temperature	170°C	Significant
Weak handles	Screw speed	90.3 RPM	Significant
High weight of chair	Material degradation	214°C	Significant

Figure 5. Final product in selected company.

7. SOLUTION

By operating the Injection Molding Machine for different operating variable we found the number of defects as shown in Table No6. For the factors Temperature, Injection speed and Screw speed there are two levels out of which we took readings for number of defects. In obtained defects which level has minimum defects that levels have been selected and freeze the respected variable.

7.1. CALCULATION OF NEW RPN

After finding solution for causes let us head towards Calculating the new RPN after taking actions and percentage decrease in RPN value. Calculations are shown below

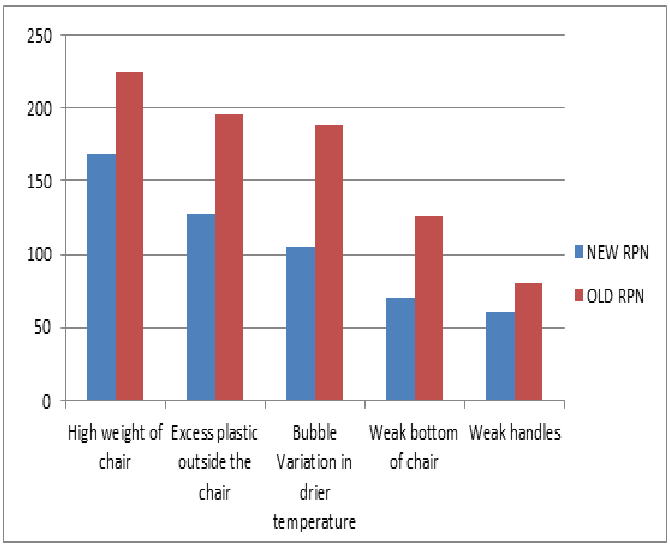

Figure 6. New vs. Old RPN

After ranking new RPN has variation which is reduced by 45% after implement these changes in company many losses overcome.

8. CONCLUSION

A service failure occurs when customers' expectations are not met. It is very important for the service designer to identify the potential service failures and take the necessary action in advance to prevent the failure from occurring and because of the limited resources; the service designer should priorities the potential service failure modes in order to take action before the service is delivered. In addition, the service blueprint is a flow chart that isolates potential fail points in a service process. It facilitates problem solving and creative thinking by identifying potential points of failure and highlighting opportunities to enhance customers' perceptions of the service. This paper has described an approach that uses process FMEA as a platform in plastic industry. The FMEA methodology is a process can overcome and reduce defects and give desired result. New RPN shows new data should be

Table 7. Solution

DEFECTS	Temperature/injection speed/screw speed	Number of defects s/hr	Cause	Solution
Bubble (Variation in drier temperature)	170°C -180°C	6/25	Variation on in drier temp	180°C standard temp
Weak bottom of chair (Injection speed)	110mm-90.3mm	4/9	Variation on injection speed	90.3 mm standard temp
Excess plastic outside the chair (barrel temp)	275°C -253°C	4/12	Variation on barrel temp	275°C standard temp
Weak handles (Screw speed)	120rpm-90rpm	3/6	Variation on screw speed	120 rpm screw speed
High weight of chair (Material degradation)	239.8°C -214.6°C	4/10	Variation on material degradation	239.8°C standard temp

Table 8. calculation

	PROBLEM DESCRIPTION	S	O	D	NEW RPN	OLD RPN	%DECREASE
1	High weight of chair	8	7	3	168	224	25%
2	Excess plastic outside the chair	8	8	2	128	196	34.7%
3	Bubble formation(Variation in drier temperature)	7	5	3	105	189	45%
4	Weak bottom of chair	5	7	2	70	126	45%
5	Weak handles	2	5	6	60	80	25%

helpful for reduction of problem ,defects as mentioned in the table and the defects are reduced from 45% cost of product and all failure every month It is designed based on the concepts of FEMA. A rate of RPN is defined for each failure and related actions were taken to decrease the rate of failure. The application of this index is so simple. There is a just simple table that must be used to define the failures

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