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A Feasibility study of TFMEA Implementation based on facilitating factors in Automatic high-pressure line casting unit

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Abstract: TFMEA is a quality management technique used to identify potential failure in an organization. It is a highly developed version of FMEA. TFMEA is an uncomplicated and valuable technique when compared with FMEA .TFMEA is devoid of any difficult computations and procedure so it facilitates illiterate labours to participate in implementing the technique. In this paper an attempt is made to study the feasibility of TFMEA in a high-pressure line of an automatic casting unit. The process and procedures of the company has studied first followed by a casual interview among all level of employees. This reveals the TQM trend in the company for continuous quality improvement. A questionnaire related to TFMEA facilitating factors were distributed to study the feasibility of TFMEA implementation in the automatic HP-line of casting unit. The study reveals that TFMEA can be successfully implemented in the automatic HP-line of casting unit.
Keywords: FMEA, TFMEA, TQM, Facilitating factor, HP- line

1. INTRODUCTION

In these recent times, researchers were conducting various failure preventions as one of the major facilitators of attaining continuous quality improvement.Failure Mode and Effect Analysis procedures are based on standards in the reliability engineering industry, both military and commercial [1].The technique FMEA has been introduced to reduce the system failure and accomplish a good quality product.Even though FMEA is an analytical method, researchers were unable to overcome the pitfalls of FMEA. However, extensive review done by researchers shows in literature[2] that there are some limitations for FMEA.This practical gap is overcome by a further modified technique of FMEA called Total Failure Mode And Effect Analysis.(TFMEA)[3].First of all the TQM trend in the company has been studied by an un-structured interview with all levels of employees. Literature [4] reveals some suggestions to implement TFMEA. Studied the literatures about TFMEA and then provide awareness about TFMEA to all employees in the unit. Then access interest among all the employees to implement this technique. A feasibility study has conducted to ensure whether TFMEA can be implemented in the company selected. Based on the facilitating factors of TFMEA from the literature [5] prepared questionnaire to conduct the feasibility study to implement TFMEA in the company. The questionnaires were distributed to all levels of employees. The company selected for the study PQR is a public sector company. According to the study it was found that implementation of TFMEA is possible to achieve zero failure in the company.

2. ABOUT THE COMPANY

The plant PQR comprises of two distinct production lines, the Conventional Molding Line and High Pressure Molding Line. The company can manufacture ferrous castings of all grades and sizes ranging from 5kg to 8000kg. The Conventional Molding Line is a semi-automatic system in which large castings are manufactured, whereas High Pressure Molding Line is a fully automated system in which smaller castings are manufactured in large quantities. The plant manufactures intricate high precision items of a mass production like cylinder block and cylinder heads for the entire range of automotive engines.PQR also has separate lines to cover the entire automotive castings from the smallest to the largest, such as housings, fly wheels, pulleys, manifolds, brakedrums etc. apart from serving the diversified needs of automobile industry. The PQR company manufactures pump castings, machine tools etc. in addition to automotive castings. Hence the company does not have a fixed product mix. Even then it has certain fixed product items because of its permanent customers. The company produces castings for five different applications at present viz. windmill applications, valve components, pump casings, tractor components and component parts for ash handling equipment.

3. MAIN OBJECTIVE

After study the TQM trend in the industry, an extensive literature review has been conducted. This search ended in the recognition of TFMEA technique. The primary objective of this work is to investigate the practicality and feasibility of implementing TFMEA for attaining continuous quality improvement in automatic

HP-line casting unit. This primary objective has been achieved through conducting interviews among the employees and distributing questionnaire based on facilitators of TFMEA in the literature.

4. RESEARCH AND METHODOLOGY

The questionnaire including 25 questions is designed considering the facilitating factors of FMEA addressed in Fig 1. given below. The questionnaires were submitted to all levels of employees of the company. The employees are randomly selected from the various departments of the company. The questionnaires were checked by the quality management experts before distributing to the respondents. A ten-point Likert-scale is considered as the answer options ranging (strongly agree, agree, neither agree nor disagree, strongly disagree, disagree). 58 questioners are distributed in the company 47 questionnaires are completed with the responds rate 90. This is the first stage of process.

4.1 Facilitating Factors of TFMEA

For the further study, From the literature[4] the facilitating factor for the successful implementation of TFMEA are top management commitment, team effort, employ involvement, quality awareness, identify costumer requirement, positive attitude of employs, training to employs, cooperation among departments.

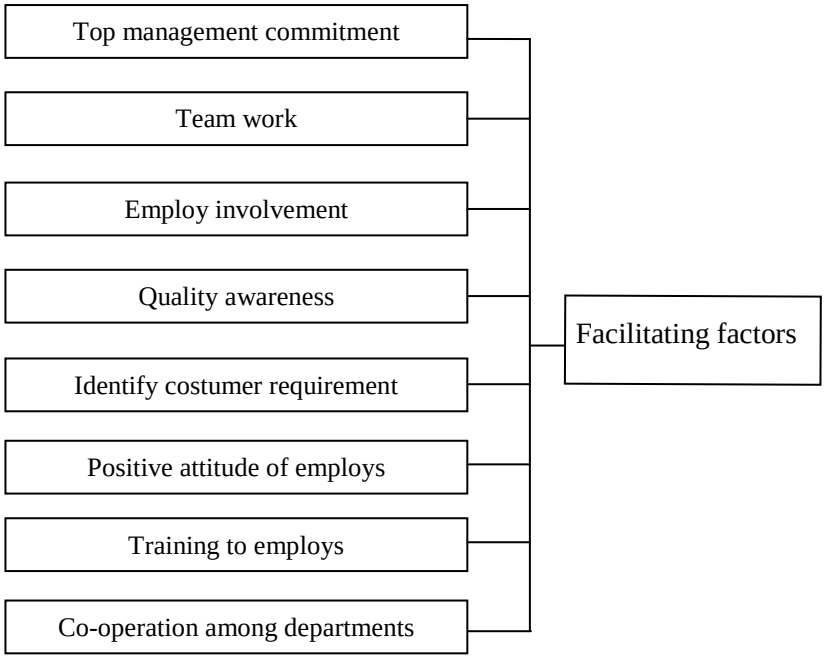

Fig 1. Facilitating factors of TFMEA

4.1.1 Top Management Commitment

Top management commitment is most significant factor for the success and existence of a company. According to the management research the success of any effort besieged at changing the potential philosophy of the organization is strongly linked with the top management commitment. Employees need to have power on their role in the company; in order to perform better and quality management cannot be fully put into practice without the top management commitment [5]. It is very arduous to change the behavior of members of the organization without the hold up of top management. It has been argued that change will more successful if the top management is committed to the change. Top management plays a significant role in critical areas such as quality management, product development and innovation.

4.1.2 Team Work

Organizations are much more likely to perform well when their people work effectively as a team. This is because good teamwork creates synergy, where the combined effect of the team is greater than the sum of individual efforts. The team members need to be able to work well together in order for the team to successfully achieve its purposes [6, 7].As well as enhancing organizations performance good teamwork benefits individuals too. In this company there were no exceeded a team work.

4.2 Employ Involvement

Employee empowerment is an integral part of any successful quality improvement process which helps employees to make decisions about their own work and environment. This also encourages people to apply the most appropriate tools and techniques. The intensity of participation of the employees will also vary with the managerial philosophy of the firm and the industrial relations environment in which it operates [8]. In general, empowerment is a core concept in a humanistic management movement that is distinguishable from the more mechanistic 'scientific management' traditions. According to the conceptual logic, people are the principle resource of organizations. Empowerment is a central concept in TQM that has been credited with making a major contribution to the Japanese revival and has been adopted with enthusiasm in other parts of the world.

4.2.2 Quality Awareness

Quality awareness in the workplace is aimed developing managers, team leaders and production staffs with knowledge, skills and attitude to create quality cultures and mind sets in the workplace. Continues improvement and meeting standards are key drivers. This implies the important of customer service, that internal customer service precedes external customer service.

4.2.3 Identify Customer Requirement

Change the complete working according to the customer requirement. It may result increase in product ability as well as profit. It is advisable to listen and ask the right questions to the customers. After identifying needs, always check for additional or related needs like right products, services, and solutions to meet customers' needs.

4.2.4 Positive Attitude of Employees

A good relationship can be established only when employees demonstrate a positive attitude towards their work and colleagues. Through positive energy, work becomes a pleasure and employees find it easier to achieve their goals. A positive attitude has significant benefits for an individual in many aspects like carrier success, productivity, leadership, decision making, and stress management.

4.2.5 Training to Employees

Training of employees is crucial for building the quality of the organization. It is essential to provide employees with new techniques and practices necessary to implement TFMEA successfully. Training and education are also necessary for teaching the TQM philosophy that requires permanent change in individual behaviors and attitudes and leads to strengthening the organization's culture. These are primary levers for change, and they have significant influence on the change process. Training should focus on building quality skills with equal attention paid to behavioral skills and quality tools needed for change in performance management and recognition.

4.1.8Co-operation among All Departments

Co-operation among all department results first-class quality work. The intensity of the relation among all departments should be higher for the excellent performance. Departments are individual but some way they are interrelated. The total works of all department outcomes the total turnover of the company.

5. FINDINGS

Based on the facilitating factors of TFMEA discussed, a questionnaire were prepared and distributed to all levels of employees in the industry. The questionnaire consists of 4 questions for each facilitating factor. Hence there are a total of 32 questions in the questionnaire. The response in Likert's scale and its standard deviation is shown in Table 1.

Table 1. Average and standard deviation of the responses from the questionnaire

Serial number	Facilitating factors	Respondents' responses in the Likert's scale of 0 – 10				Average value	Standard Deviation
		Questions					
		Q1	Q2	Q3	Q4		
1	Top management commitment	10	9	8	9	9	0.8165
2	Team work	9	8	9	7	8.25	0.9574
3	Employee involvement	10	8	8	9	8.75	0.9574
4	Quality awareness	8	7	7	8	7.5	0.5774
5	Identify costumer requirement	6	8	8	7	7.23	0.9574
6	Positive attitude of employs	10	5	6	7	7	2.1602
7	Training of employs	8	3	7	5	5.75	2.2174
8	Cooperation among departments	6	3	6	6	5.25	1.5000

Top management commitment is the success factor of TFMEA which is having highest Likert's value of response. Quality Awareness is least with value 0.5774. This indicates that there is not much proper awareness of quality of product. In the case of TFMEA training of employees, the standard deviation of the responses of the respondents is highest with the value of 2.2174. This indicates the difference in opinions of the respondents over the implementation of the actions suggested to overcome the failure. This kind of differential opinion is attributed to the fact that, two of the respondents are not interested in TFMEA programme. Hence their perceptions over overcoming the failures varied. In this background, the need of classifying the actions based on their acceptance and intricacies of implementing them in the automatic HP-line industry was realized. The average of values indicated by the respondents to anticipate the rate of success in implementing the suggested actions is shown in Table 2.

Table 2. Respondents' anticipation over the successful implementation of actions as suggested to the HP-line of casting unit.

TFMEA number	Name of failure mode	Respondent's average values in the Likerts' scale of 0 – 10
1	Top management commitment	9
2	Team work	8.25
3	Employee involvement	8.75
4	Quality awareness	7.5
5	Identify costumer requirement	7.23
6	Positive attitude of employs	7
7	Training of employs	5.75
8	Cooperation among departments	5.25

The Fig.1 shows the average value of response to the questionnaire and the standard deviation. It infers that the implementation of TFMEA can be feasible if the standard deviation is having less value.

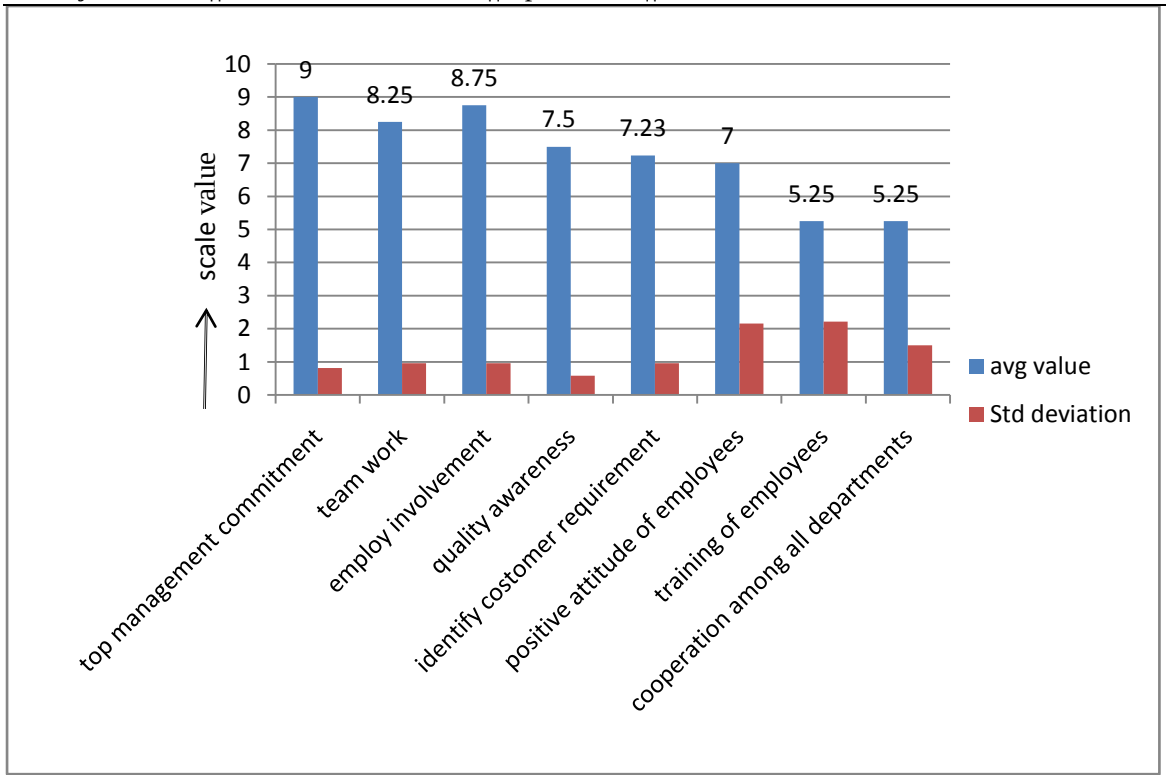

Fig1. Average and standard deviation of the responses of the respondents

The Table 3. shows category of actions suggested for each values of responds. If the average value is less than 3 the TFMEA implementation is practicable. TFMEA cannot be implemented if the values are between 3&6, if the average value is between 6 and 8,TFMEA can be easily implemented.

Table 3 Actions implementable categorization chart

Response Value	**Category of actions suggested**
Average value < 3	Very difficult to implement
Average value >3 and less than 6	Difficult to implement
Average value >6 and less than 8	Easy to implement
Average value >8	Very Easy to implement

Based on the analysis of the responses of the respondents, the ease of implementing the actions suggested by the TFMEA team to overcome the various failures were categorized under the titles 'Very Easy to implement' , 'Easy to implement', 'Difficult to implement' and 'Very Difficult to implement'. The categorization of failure modes made using these rules are presented in Table 4.

Table 4. Categorization of failure mode

Failure number	**Failure mode**	**Category**
1	Top management commitment	Very easy to implement
2	Team work	Very easy to implement
3	Employee involvement	Very easy to implement
4	Quality awareness	Easy to implement
5	Identify costumer requirement	Easy to implement
6	Positive attitude of employs	Easy to implement
7	Training of employs	Difficult to implement
8	Cooperation among departments	Difficult to implement

It is evident that, most of the actions suggested to overcome the failure modes are easily implementable at the HP-line of casting unit. Improper training of employees is one of the failure modes and its corrective

action suggested is timely training should be given to the employees when technology advances. There is limited co-operation among all department in the organization has found as another failure mode. The corrective action suggested is the managers must ensure the inter-departmental meeting related to the failures must be conducted. Here the result shows almost 80% of the answer leads to easy implementation. The percentage categorization of the actions suggested from the viewpoint of the respondents is presented in Table 5.

Table 5 Percentage categorization of implementation actions suggested by the TFMEA team

Serial number	Category of actions suggested	Percentage categorization
1	Very difficult to implement	10 %
2	Difficult to implement	30 %
3	Easy to implement	30%
4	Very Easy to implement	30%

As shown in Table 5, the 60 % of the actions suggested by the TFMEA team members are either 'very easy' or 'easy' to implement in HP-line of casting unit.. The 30 % of the actions suggested by the TFMEA members are 'difficult to implement' at the HP-line of casting unit. Only in the case of 10 % of the failures modes, the actions suggested for overcoming them is very difficult to implement at the HP-line of casting unit. In the context of these observations, it was felt that the top management of HP-line of casting unit may be persuaded to start implementing the 'very easy' actions and then proceed to implement the 'easy', 'difficult' and then the 'very difficult' actions.

6. CONCLUSION

In order to check the feasibility of TFMEA technique in the HP-line casting industry, 8 distinct facilitating factors are considered to carry out the methodology. The findings of the study show that all levels of the employees in the company were aware about the continuous quality improvement techniques like TFMEA. The company practices quality management technique like FMEA once only for the documentation of accreditation. Response based on the facilitator 'top management commitment' has the highest value among the other TFMEA facilitating factors. The next two facilitating factors have lesser response values than average. Also remaining facilitating factor has the lowest response values. The analysis has revealed that TFMEA is a technique which is feasible in the automatic HP-line of casting industry to overcome failures and thereby to improve quality as well as the productivity of the product. On the whole the experience of carrying out the feasibility study in HP-line casting industry has revealed that the TFMEA technique has the potential to overcome defects that occur during the manufacturing of casting product.

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