

# **Critical Success Factors for TFMEA Implementation in Automatic High-Pressure Line Casting Unit**

Raji Rajan<sup>1</sup>, Sanjai Sreekumar<sup>2</sup>, Shijo Shaji<sup>3</sup>, V.R. Pramod<sup>4</sup>

Associate Professor, Department of Mechanical Engineering, SNIT, Adoor, Kerala, India<sup>1</sup>

UG. Student, Department of Mechanical Engineering, SNIT, Adoor, Kerala, India<sup>2</sup>

UG. Student, Department of Mechanical Engineering, SNIT, Adoor, Kerala, India<sup>3</sup>

Associate Professor, Department of Mechanical Engineering, NSS College of Engineering, Palakkad, Kerala, India<sup>4</sup>

**ABSTRACT:** In this paper an attempt is made to investigate the critical success factors for the TFMEA implementation in automatic high-pressure line casting unit. Once the success factors are known it is easy to implement TFMEA. Questionnaire surveys & semi structured interviews has been applied to achieve the objective of this paper. The findings of this project show that the success factors for implementing TFMEA in automatic high-pressure casting unit are Top management commitment, Identifying customer requirements, Training to employees, Co-operation between departments, Positive attitude of employees, Team work, Commitment of employees, Quality improvement culture.

**KEYWORDS:** Critical Success Factor, TFMEA, QM, TQM, HP-Line

## **I. INTRODUCTION**

The company can achieve zero failure by implementing Total Quality Management techniques like TFMEA. This can be attained by considering success factor like Management leadership, Customer focus, Training to employees, Employee relationship, Team work, Commitment of employees. QM and TQM are most extensively used in industries for continuous quality improvement. The United States, Japan and The European Union have been implementing total quality management since the end of the twentieth century as an ideal technique to improve quality. FMEA is an analytical approach for identifying all probable failures in design and manufacturing. FMEA actions are based on ethics in the consistency manufacturing industry, both armed and profitable [1]. Certain modified forms of FMEA has found while surveying the literatures. Even though FMEA is an effective tool for continuous quality improvement, few papers have highlighted the deficiencies of FMEA, they are Ahuja and Khamba [2], Estorillo and Posso [3][4][10]. The conventional FMEA has some pitfalls so that it cannot be holistically remove the failures. TFMEA can be considered as an improved version of failure mode and effect analysis introduced by Devadasan et al [12]. The literatures reveal that TFMEA is a powerful technique for continuous quality improvement. Another literature has specified suggestions to implement TFMEA[9]. Extensive literature investigation has been conducted and found that TFMEA has been implemented in forging industry [11]. In this paper an attempt has been made to find out the critical success factors for TFMEA implementation in automatic High-Pressure line casting unit. Initially casual interactions and interviews were conducted among employees of various departments in the company.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

## II. LITERATURE SURVEY

From the wide-ranging survey of literature, it was found that by implementing TFMEA with the contribution of the various departments in an organization can achieve complete eradication of the failure. Also this will improve the quality of the product. So it is necessary to study the TQM trend in the company. Exposing the importance of failure prevention for quality products, studying the awareness of FMEA in the company is also important. The steps involved in TFMEA implementation are identification of soft areas of TFMEA implementation, create methods and procedures for recording failures, develop organization for carrying out TFMEA, identify the associated departments and cause of failure, develop TFMEA tables for each departments, develop TFMEA cards or drawings, implement and show results to the management, conduct awareness meeting among various levels of employees and management, plan for full implementation, develop and maintain TFMEA system, ensure the organizations vision and policy on TFMEA implementation.

## III. ABOUT THE COMPANY

The company ABC selected for this case study is a public-sector unit of casting run by the Government of Kerala, India, established in 1981 and started commercial production in the year 1986. The optimum capacity of the unit is 18000 tons per annum. They manufacture castings like cylinder block, cylinder heads for the entire range of automotive engines. It has separate lines to cover the entire automotive castings for the smallest to the largest such as housings, pulley, manifold, brake drums. This company manufactures pump castings, machine tools in addition to automotive castings. The company has mainly two casting units, conventional casting unit and fully automatic high-pressure line unit called HP- line. It is a German made fully automatic casting machine unit. The main processes include production of several types of machine components by various manufacturing processes such as casting, forging, forming etc. TFMEA can be implemented in any part of the organization to determine chances of failure and suggest suitable preventive measures.

## IV. RESEARCH METHODOLOGY

There are two methods where used to collect the data, they are survey questionnaires and semi-structure interviews. The purpose of the questionnaire is to identify the critical success factors for TFMEA implementation in automatic high-pressure line casting unit. A total of 80 copies of questionnaire were distributed to the 80 employees in automatic high-pressure line casting unit. The questionnaire includes 24 statements to find-out the critical success factors for the implementation of TFMEA. Among 80 employees only 60 employees respond to the questionnaires. Questionnaire helps to retrieve the useful information from people for the analysis of the data. Since questionnaire depends on the decision of employees, the value of the answer is significant. In this research a five-point Likert scale is considered. As per the information collected from the employees and using five-point Likert's scale corresponding charts were plotted. Critical success factors play a main role in the successful implementation of TFMEA in a company. According to the literature [11] the critical success factor for the successful implementation of TFMEA are Top management commitment, Identifying customer requirements, Training to employees, Co-operation between departments, Positive attitude of employees, Team work, Commitment of employees, Quality improvement culture.

**Top Management Commitment** : Top management commitment is core factor for the achievement and existence of an organization. The firms with high top management commitment produce high quality produce despite variations in individual constructs[5].

**Identifying Customer Requirements** : Change the entire working as per the customer necessity. It might come about increment in item capacity and benefit. It is prudent to tune in and ask the correct inquiries to the clients. In the wake of distinguishing needs, dependably check for extra or related needs like right items, administrations, and answers for address customer's issues.

## International Journal of Innovative Research in Science, Engineering and Technology

*(A High Impact Factor, Monthly, Peer Reviewed Journal)*

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

**Training to Employees** : Training of employees is critical for building the nature of the association. It is basic to give representatives new procedures and practices important to actualize TFMEA effectively. Preparing and instruction are likewise fundamental for educating the TQM theory that requires lasting change in singular practices and states of mind and prompts fortifying the associations culture.

**Co-operation between Departments** : Co-operation among all departments in an organisation comes about top of the line quality work. The force of the connection among all divisions ought to be higher for the amazing execution. Offices are individual yet some way they are interrelated. The aggregate works of all office results the aggregate turnover of the organization.

**Positive Attitude of Employees** : A good relationship can be built up just when representatives show an uplifting state of mind towards their work and partners. Through positive vitality, work turns into a delight and representatives think that its less demanding to accomplish their objectives. An inspirational mentality has critical advantages for a person in numerous angles like bearer achievement, profitability, administration, basic leadership, and stress administration.

**Team Work** : Organizations are considerably more liable to perform well when their kin function admirably as a group. This is on the grounds that great collaboration makes cooperative energy, where the consolidated impact of the group is more prominent than the total of individual endeavours. The colleagues should have the capacity to function admirably all together for the group to effectively accomplish its motivations [6,7].

**Commitment of Employees** : Representative strengthening is a vital part of any fruitful quality change process which causes workers to settle on choices about their own work and condition. This additionally urges individuals to apply the most fitting apparatuses and procedures. The force of investment of the workers will likewise shift with the administrative rationality of the firm and the mechanical relations condition in which it works [8].

**Quality Improvement Culture** : Quality mindfulness in the work environment is pointed creating supervisors, group pioneers and generation staffs with learning, aptitudes and demeanour to make quality societies and attitudes in the working environment. Proceeds with change and meeting guidelines are key drivers.

Fig. 1 shows the critical success factors and the related statements.  $S_1, S_2$  etc., are the statements included in the questionnaire related to the facilitating factors selected.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

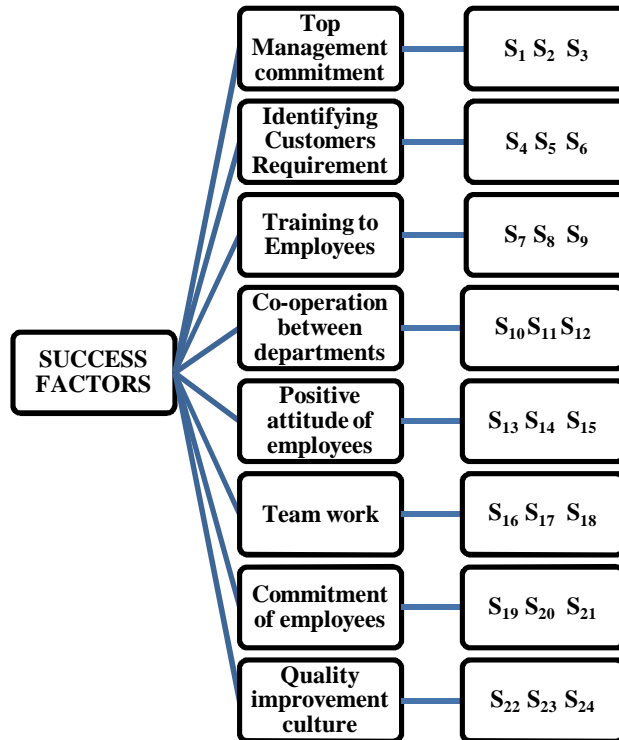


Fig 1. Critical success of TFMEA and statements.

In order to find out the mean and standard deviation for each critical success factors we assign ratings for each grade. Table 1. shows the rating for each grade. For the grade ‘Strongly agree’ the rating given is 5, for the grade ‘Agree’ the rating given is 4 , for the grade ‘Neither agree nor disagree’ the rating given is 3 , for the grade ‘Disagree’ the rating given is 2, for the grade ‘Strongly disagree’ the rating given is 1.

Table 1. The Ratings for Each Grades

Grade	Rating
I – Strongly agree	5
II – Agree	4
III – Neither agree nor disagree	3
IV – Disagree	2
V – Strongly disagree	1

## V. FINDINGS

Based on the critical success factors of TFMEA, a questionnaire were prepared and distributed to all levels of employees in the industry. The questionnaire consists of 3 statements for each critical success factor. Hence there are a

## International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

total of 24 statements in the questionnaire. Table 2 shows the rating of each statements done by 60 employees in the Automatic High-Pressure Line Casting Unit.

Table 2. Employees Rating

	<b>R<sub>1</sub></b> (Strongly Agree)	<b>R<sub>2</sub></b> (Agree)	<b>R<sub>3</sub></b> (Neither Agree nor Disagree)	<b>R<sub>4</sub></b> (Disagree)	<b>R<sub>5</sub></b> (Strongly Disagree)
S <sub>1</sub>	60 * 5 = 300	0 * 4 = 0	0 * 3 = 0	0 * 2 = 0	0 * 1 = 0
S <sub>2</sub>	59 * 5 = 295	1 * 4 = 4	0 * 3 = 0	0 * 2 = 4	0 * 1 = 0
S <sub>3</sub>	57 * 5 = 285	3 * 4 = 12	1 * 3 = 3	1 * 2 = 2	0 * 1 = 0
S <sub>4</sub>	46 * 5 = 230	9 * 4 = 36	0 * 3 = 0	3 * 2 = 6	2 * 1 = 2
S <sub>5</sub>	47 * 5 = 235	8 * 4 = 32	1 * 3 = 0	2 * 2 = 0	2 * 1 = 0
S <sub>6</sub>	46 * 5 = 230	10 * 4 = 40	1 * 3 = 3	2 * 2 = 4	1 * 1 = 0
S <sub>7</sub>	41 * 5 = 205	8 * 4 = 32	0 * 3 = 0	7 * 2 = 14	4 * 1 = 4
S <sub>8</sub>	40 * 5 = 200	10 * 4 = 40	1 * 3 = 3	6 * 2 = 12	4 * 1 = 4
S <sub>9</sub>	42 * 5 = 210	10 * 4 = 40	0 * 3 = 0	6 * 2 = 12	2 * 1 = 2
S <sub>10</sub>	33 * 5 = 165	8 * 4 = 32	1 * 3 = 3	10 * 2 = 20	8 * 1 = 8
S <sub>11</sub>	34 * 5 = 170	7 * 4 = 28	0 * 3 = 0	12 * 2 = 24	7 * 1 = 7
S <sub>12</sub>	32 * 5 = 160	9 * 4 = 36	1 * 3 = 3	9 * 2 = 18	8 * 1 = 0
S <sub>13</sub>	38 * 5 = 190	12 * 4 = 48	0 * 3 = 0	6 * 2 = 12	4 * 1 = 4
S <sub>14</sub>	39 * 5 = 195	11 * 4 = 44	0 * 3 = 0	7 * 2 = 14	4 * 1 = 4
S <sub>15</sub>	37 * 5 = 185	13 * 4 = 52	0 * 3 = 0	5 * 2 = 10	5 * 1 = 5

	<b>R<sub>1</sub></b> (Strongly Agree)	<b>R<sub>2</sub></b> (Agree)	<b>R<sub>3</sub></b> (Neither Agree nor Disagree)	<b>R<sub>4</sub></b> (Disagree)	<b>R<sub>5</sub></b> (Strongly Disagree)
S <sub>16</sub>	50 * 5 = 250	8 * 4 = 48	1 * 3 = 3	1 * 2 = 2	0 * 1 = 0
S <sub>17</sub>	52 * 5 = 260	7 * 4 = 28	0 * 3 = 0	1 * 2 = 2	0 * 1 = 0
S <sub>18</sub>	51 * 5 = 255	9 * 4 = 36	0 * 3 = 0	1 * 2 = 2	0 * 1 = 0
S <sub>19</sub>	50 * 5 = 250	7 * 4 = 28	1 * 3 = 3	2 * 2 = 4	0 * 1 = 0
S <sub>20</sub>	50 * 5 = 250	8 * 4 = 32	0 * 3 = 0	2 * 2 = 4	0 * 1 = 0
S <sub>21</sub>	49 * 5 = 245	11 * 4 = 44	0 * 3 = 0	1 * 2 = 2	1 * 1 = 1
S <sub>22</sub>	47 * 5 = 235	10 * 4 = 40	0 * 3 = 0	2 * 2 = 4	1 * 1 = 1
S <sub>23</sub>	48 * 5 = 240	9 * 4 = 36	0 * 3 = 0	2 * 2 = 2	1 * 1 = 1
S <sub>24</sub>	46 * 5 = 230	8 * 4 = 32	1 * 3 = 3	4 * 2 = 8	1 * 1 = 1

For better understanding the rating done by 60 employees for each critical success factor is plotted in the Fig 2. to Fig 9. In Fig 2. for the grade 'Strongly agree' has given a rating of 5 and 99% of response attained.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

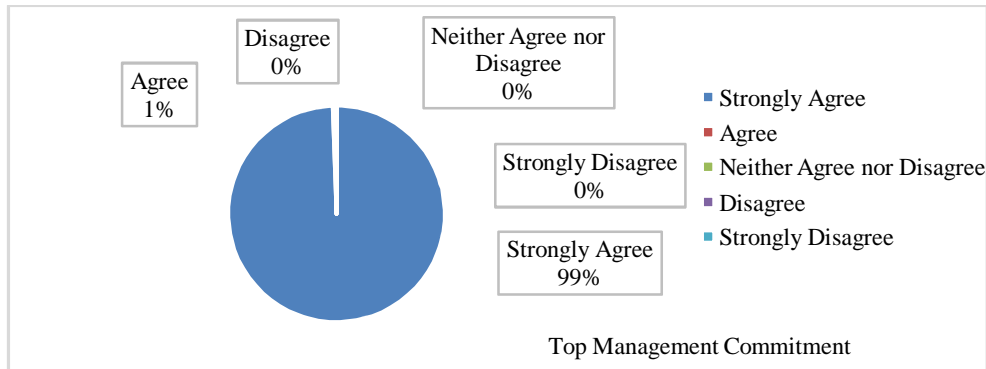


Fig 2. Top Management Commitment

In Fig 3. for the grade ‘Strongly agree’ has given a rating of 5 and 85% of response attained and ‘Agree’ has given a rating of 4 and 14% of response attained.

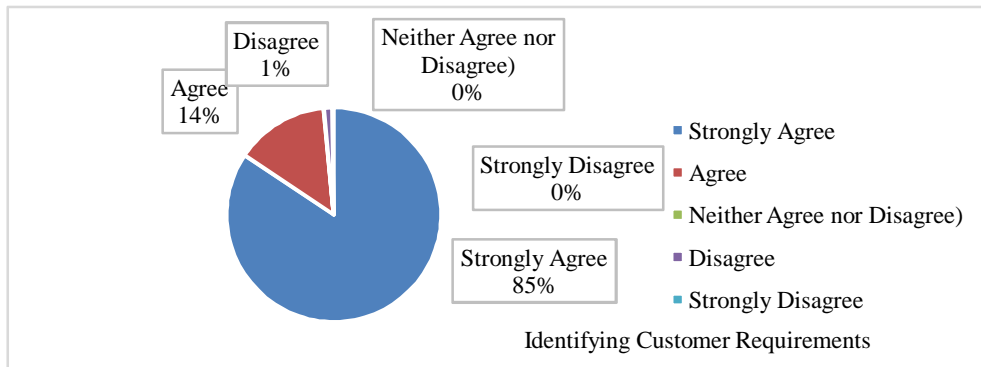


Fig 3. Identifying Customer Requirements

In Fig 4. for the grade ‘Strongly agree’ has given a rating of 5 and 80% of response attained, ‘Agree’ has given a rating of 4 and 15% of response attained and ‘Disagree’ has given a rating of 2 and 5% of response attained.

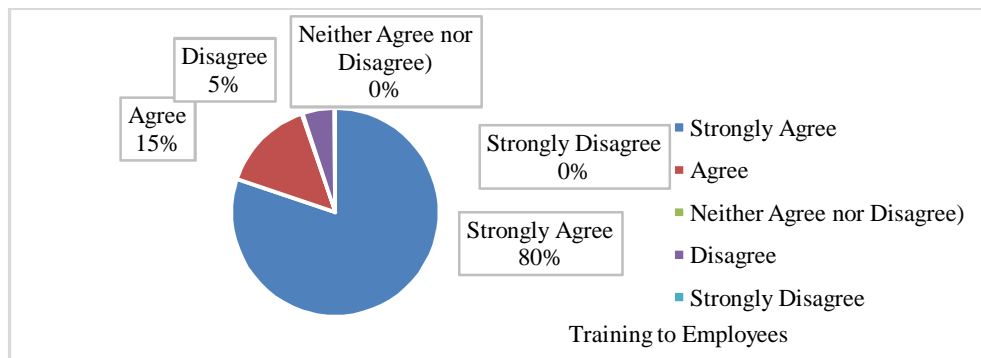


Fig 4. Training to Employees

In Fig 5. for the grade ‘Strongly agree’ has given a rating of 5 and 74% of response attained, ‘Agree’ has given a rating of 4 and 14% of response attained and ‘Disagree’ has given a rating of 2 and 9% of response attained.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

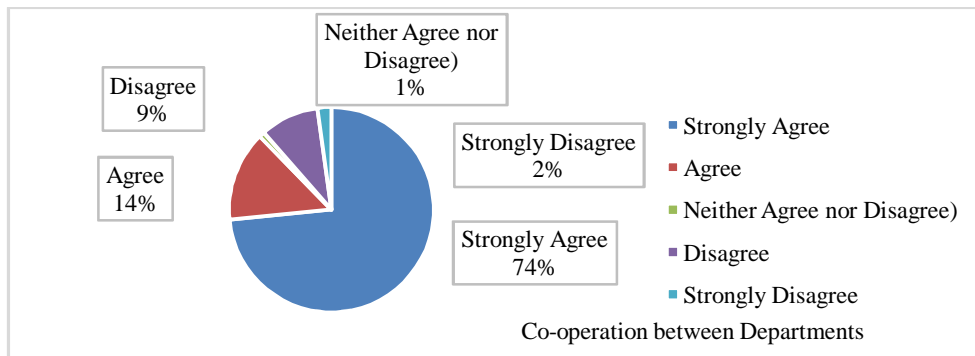


Fig 5. Co-operation between Departments

In Fig 6. for the grade ‘Strongly agree’ has given a rating of 5 and 74% of response attained, ‘Agree’ has given a rating of 4 and 19% of response attained and ‘Disagree’ has given a rating of 2 and 5% of response attained.

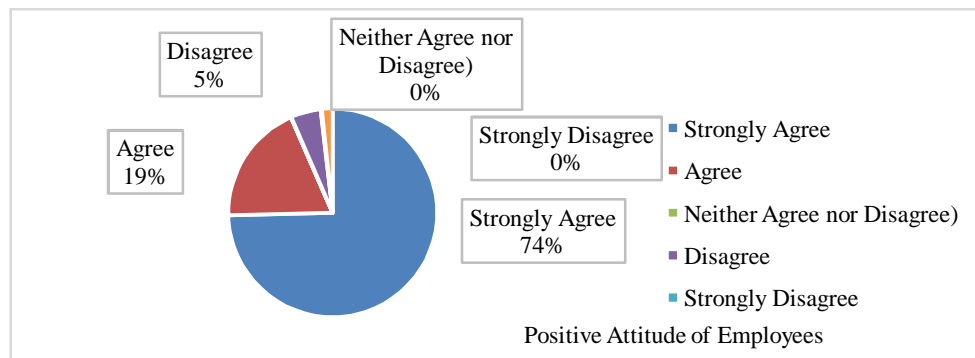


Fig 6. Positive Attitude of Employees

In Fig 7. for the grade ‘Strongly agree’ has given a rating of 5 and 86% of response attained, ‘Agree’ has given a rating of 4 and 13% of response attained and ‘Disagree’ has given a rating of 2 and 1% of response attained.

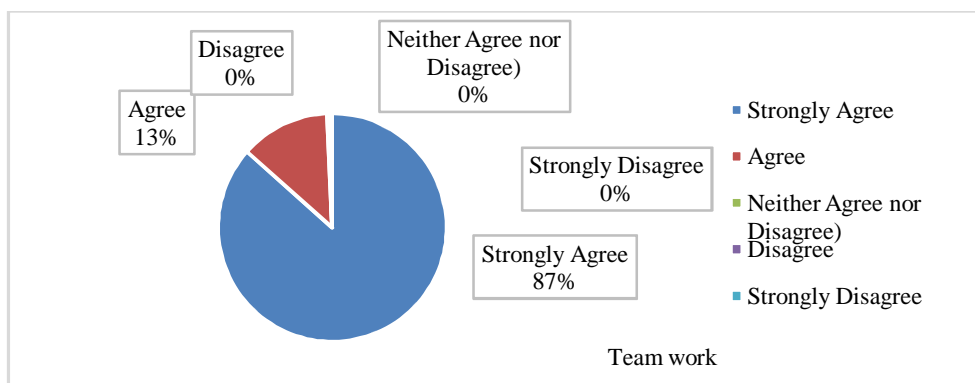


Fig 7. Team work

In Fig 8. for the grade ‘Strongly agree’ has given a rating of 5 and 86% of response attained, ‘Agree’ has given a rating of 4 and 12% of response attained and ‘Disagree’ has given a rating of 2 and 1% of response attained.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

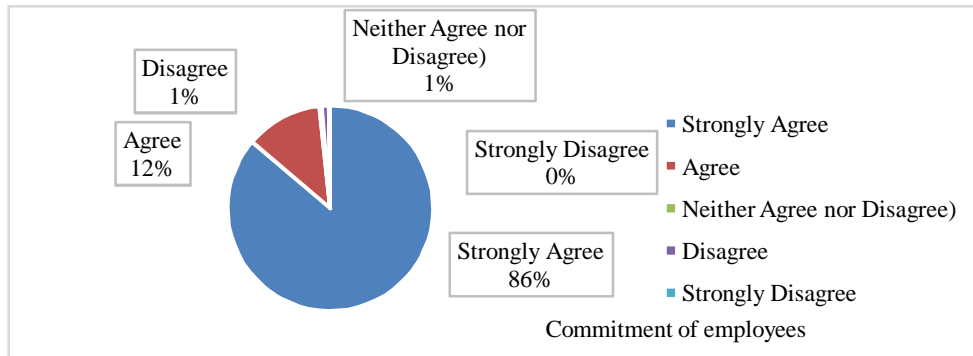


Fig 8. Commitment of employees

In Fig 9. for the grade ‘Strongly agree’ has given a rating of 5 and 85% of response attained, ‘Agree’ has given a rating of 4 and 13% of response attained and ‘Disagree’ has given a rating of 2 and 2% of response attained.

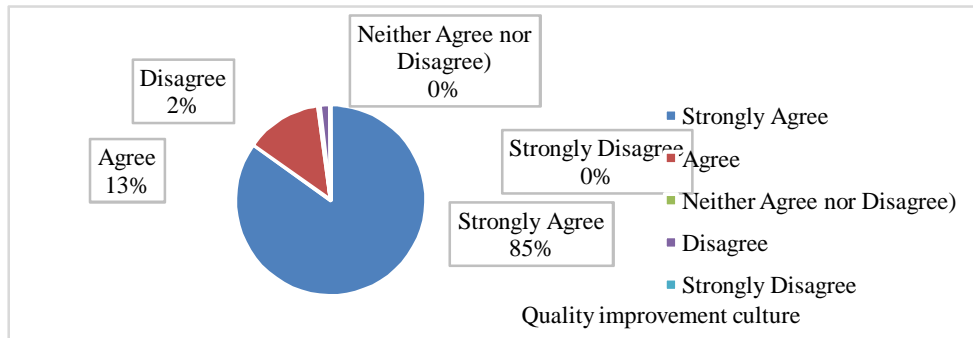


Fig 9. Quality improvement culture

The estimation of each TFMEA factor has been evaluated by a gathering of inquiries utilizing a five- point Likert scale technique. Members were requested to score their answer from 1-5 with concur or can't help contradicting the given articulations. Utilizing this scale, the normal of the measure is 3 ((1+2+3+4+5)/5), minimum should be greater than 3 for the successful implementation of TFMEA in automatic high-pressure line casting unity. Table 3. shows mean and standard deviation of the responses from the questionnaire. These factors are Management leadership, Identifying customer requirements, Training to employees, Co-operation between departments, Positive attitude of employees, Team work, Commitment of employees, Quality improvement culture.

Critical success factors	Mean	Standard deviation
Top Management Commitment	4.97	0.11
Team work	4.80	0.519
Commitment of employees	4.75	0.63
Quality improvement culture	4.64	0.78
Identifying customer requirements	4.50	0.95
Positive attitude of employees	4.21	1.25
Training to employees	4.18	1.35
Co-operation between departments	3.80	1.58

Table 3. Mean and standard deviation of the responses from the questionnaire



# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

The majority of the interrogators agreed that these factors play a significant role in achieving effective implementation of TFMEA. This outcome is maintained by other lessons conducted in the arena. Salaheldin (2009) settled that Management leadership plays a significant role in promoting TQM implementation in Egypt. Das, et al. (2011), found out that top administration commitment, and customer attention plays an important part in the successful TFMEA execution. Management leadership is the success factor of TFMEA which is having highest Likert's value of response and it has lowest standard deviations. Team work is having the second highest Likert's value of response which indicate that team work is required for the proper implementation of TFMEA and to reduce the time for the production. Quality improvement culture is having a value of standard deviation of 0.78, this indicate that not much priority is given to the quality of product. In the case of TFMEA training of employees, the standard deviation of the responses of the respondents is second highest with the value of 1.35. These mean and standard deviation are shown in Fig 10. This indicates the distinction in opinions of the respondents over the implementation of the actions advised to overcome the failure. In this contextual, the need of categorizing the actions based on their approval and intricacies of implementing them in the automatic HP-line industry was understood.

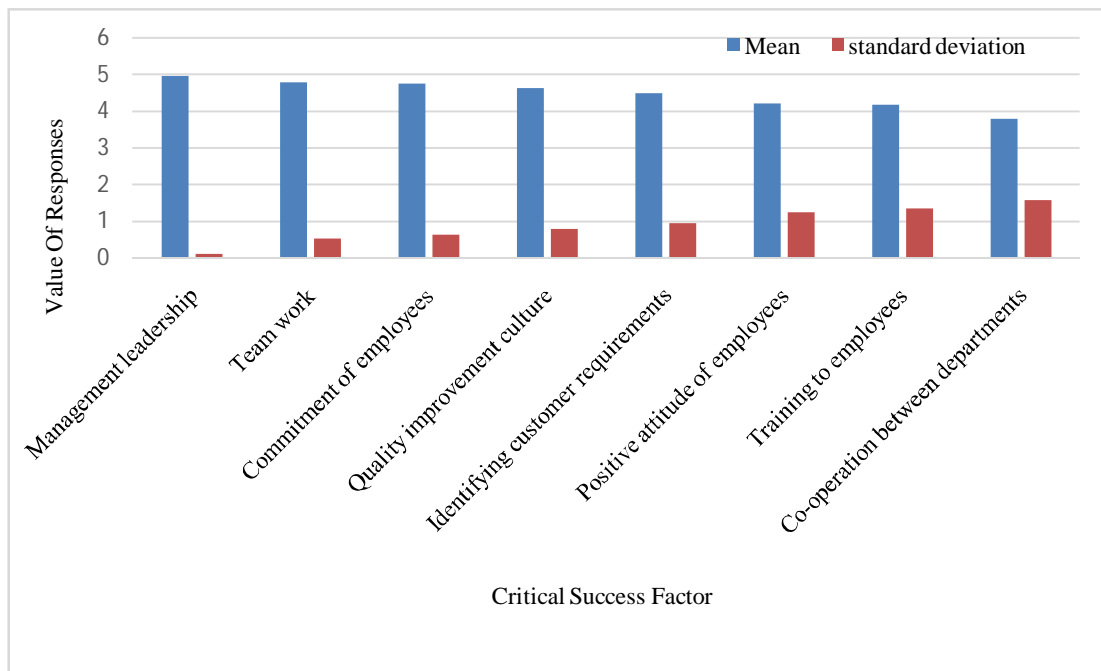


Fig 10. Mean and Standard Deviation of the responses of the respondents

## VI. CONCLUSION

In actual practice Implementation of TFMEA in an organization is not very easy. A team of experts along with workers from every department has to be formed. The management needs to be convinced and given proper awareness about the technique and the preventive actions to be implemented. Participation of all members as a team can make a good result. In order to implement TFMEA technique in the HP-line casting industry, 8 Critical success 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. Reply based on the organizer top management commitment has the highest value among the other TFMEA critical success factors. The next two critical success factors like 'training to employees' and 'co-operation between departments' have slighter response values than average.

# International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: [www.ijirset.com](http://www.ijirset.com)

Vol. 7, Issue 5, May 2018

The remaining critical success factor has the lowest response values. The analysis has exposed that TFMEA is a technique which is practicable in the automatic HP-line of casting industry to overcome failures and thereby to improve quality as well as the efficiency of the product. Hence this paper discusses the critical success factors to implement TFMEA in automatic HP -line casting industry.

## REFERENCES

- [1] Guidance on Failure Modes & Effects Analyses (FMEAs), "The International Marine Contractors Association", IMCA M 166, April 2002
- [2] I.P.S. Ahuja, J.S. Khamba, (2008) "Total productive maintenance: literature review and directions", International Journal of Quality & Reliability Management, Vol. 25 Issue: 7, pp.709-756
- [3] Estorillo, C., and Posso, R.K., 2010. The Reduction of irregularities in the use of "process fmea". International Journal of Quality and Reliability Management, vol.27, no.6, pp.721-733.
- [4] Liu H C, Liu L and Liu N 2013 Expert Syst. Appl.40.828-38.
- [5] Sanjay L. Ahire, K. C. O'Shaughnessy, (1998) "The role of top management commitment in quality management: an empirical analysis of the auto parts industry", International Journal of Quality Science, Vol. 3 issue: 1, pp.5-37
- [6] Lepine JA, Piccolo RF, Jackson CL, Mathieu JE, Saul JR. A Meta-Analysis of Teamwork Processes: Tests of A Multidimensional Model and Relationships with Team Effectiveness Criteria. Personnel Psychology. 2008;61(2): 273–307.
- [7] Rousseau V, Aubé C, Savoie A. Teamwork behaviors: A review and an integration of frameworks. Small Group Research. 2006Jan;37(5):540–70
- [8] Gill, Colin, 1993, "The involvement of trade unions in quality: evidence from EC enterprises", New Technology, Work and Employment, Vol. 8, No. 2, September, pp. 122-133
- [9] I. Alfred Ebenezer, S.R. Devadasan, C.G. Sreenivasa, R. Muruges. (2011). " Total failure mode and effects analysis in tea industry: A theoretical treatise", Total Quality Management & Business Excellence Vol. 22, No. 12, December 2011, 1353–1369
- [10] Chin, K.S., Wang, Y.M., Poon, G.K.K., & Yang, J.B. (2009). Failure mode and effects analysis by data envelopment analysis. Decision Support Systems, 48(1), 246–256
- [11] Raji Rajan, V. R.Pramod.' Interpretive Structural Model for Understanding the Facilitators of TFMEA", published in IJMTER journal Volume 3, Issue 5; May 2016
- [12] Devadasan, S.R., Muthu, S., Samson, R.N. and Sankaran, R.A. (2003) 'Design of total failure mode and effects analysis programme', International Journal of Quality and Reliability Management, Vol. 20, No. 5, pp.551–568