

A SURVEY BASED STUDY TO ASCERTAIN THE CONTRIBUTING FACTORS FOR THE IMPLEMENTATION OF TPM IN SMES

Abstract

Maintenance is considered to be a key activity in any manufacturing industry to improve the performance of plant and machineries. Total Productive Maintenance, Total Quality Management, Lean Production, Six Sigma, Just-in-time are some of the performance improving initiatives executed by several manufacturing organizations. This article highlights the extent to which TPM is being used in the selected Enterprises of Small to Medium scale (SMEs). The study is conducted with the aid of a questionnaire comprising of 22 questions related to TPM implementation. The responses are received from the executives, line engineers, managers and supervisors from various SMEs involving manufacturing and non-manufacturing organizations. A total of 126 responses are received from various SMEs and this gives the sample size. A 5-point Likert scale is used to rate the responses. The responses collected are analysed with the help of statistical tools such as bar charts, interpreted methodically and inferences are drawn. Analysis indicate that only 41 SMEs out of 126 have chosen TPM for improving their performance and remaining are yet to initiate the use of it. The study also ascertains the possible reasons for not initiating the implementation of TPM in the SMEs identified.

Keywords: Lean Production, Six Sigma, Just-in-time, Likert scale, questionnaire, statistical tools.

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I. INTRODUCTION

Total Productive Maintenance (TPM) and Total Quality Management (TQM) are the two important performance improvement programmes widely used in the area of manufacturing and operations management [1]. Total Productive Maintenance (TPM) is a Japanese concept originated in the year 1971. S. Nakajima was the pioneering founder of the TPM. He has given the basic definition of TPM, its importance, objectives and steps in its implementation [2]. The main aim of TPM is to reduce equipment downtime, reduce major losses and wastages associated with the production, enhance the productivity, quality of the product, safety and morale of the employees [3,4,5]. It helps to achieve highest performance level of an equipment or a process without breakdowns, quality defects, accidents and wastages [6]. It makes every employee of an organization concerned about his machine or process, its maintenance, quality and efficiency, thus brings a sense of ownership and responsibility in him [7]. TPM can be employed organization-wide in various types of industries to improve their performance and satisfy their customer requirements by meeting product quality and standards. TPM brings maintenance and operation functions together and helps in promoting autonomous maintenance by the operators in their daily activities [8,9]. It improves equipment availability, performance and quality rate, thus increasing its Overall Equipment Effectiveness (OEE), covering the entire life of the equipment [10,11]. TPM includes 8 pillars namely 5S (Sort, Set in order, Shine, Standardize and Sustain), Continuous improvement, Planned maintenance, Autonomous maintenance, Quality maintenance, Training, TPM for Administrative functions, Safety, Health and Environment [12]. 5S is like a foundation in TPM and all eight pillars are supported by 5S. [13].

This research work targets only small and medium sized enterprises involving manufacturing industries and non-manufacturing organizations such as process and service industries. These SMEs cover a major percentage of business organizations, supplying either products or services to the large scale enterprises. These SMEs play a major role in the growth of a nation as well as its economy [14-16]. TPM, being a performance improvement programme, will definitely contribute to the overall development of a SME, ensuring its survival in the global competitive market. TPM implementation is relatively easier in case of SMEs compared to large scale enterprises. All SMEs do not call for the execution of 8 TPM pillars in a phased manner. The No. of pillars need to be executed in SMEs is relatively less than those compared to large scale enterprises. Hence TPM can be effectively implemented in SMEs as well [17-19].

II. METHODOLOGY

This quantitative research is materialized through a questionnaire designed to collect primary data using 22 specific questions related to TPM and its implementation. Secondary data collection was done by referring journal and conference papers, text books, websites, etc. The questionnaire was randomly given to executives, managers, line engineers and supervisors of the selected SMEs. Experts were consulted and interviews were held with few random respondents of the identified SMEs to check the capability of the questionnaire to evaluate the attributes required in the study. It has been confirmed that the questionnaire design is well-structured and it has got the capability to gather the primary data essential for the research. Using Google forms the questionnaire was circulated to 160 respondents of different SMEs involving manufacturing and non-manufacturing organizations in India and

overseas. The number of responses received was 126 (sample size). A 5-point Likert scale was used to rate the responses. in which 1-Strongly Disagree, 2- Disagree, 3- Neutral, 4- Agree and 5-Strongly Agree. Statistical tools were used to perform data analysis and inferences were drawn after thorough interpretation. The research is aimed to recognize the levels to which the TPM is being used in the selected SMEs and also to identify the possible reasons for the non-usage of TPM in these SMEs.

III.RESULTS & DISCUSSION

This survey is conducted on Small and Medium Sized Enterprises (SMEs) in India and abroad. The main aim of this study is to verify the usage level of TPM and also to identify the factors hindering the usage of TPM in these SMEs.

1. **Questionnaire Design for the Research:** This survey was initiated by preparing a questionnaire having a list of 22 questions. The questionnaire was designed to collect the right information from the respondents of selected SMEs. The questionnaire was prepared on the basis of literature review and the discussions held with academicians, professionals and experts in the field of total productive maintenance. The design of the questionnaire was intended to:

- Find out the usage and awareness level of TPM in the selected SMEs.
- Find out the current maintenance system used and the level of computerization in the selected SMEs.
- Identify top management support, initiation and participation for TPM implementation in the selected SMEs.
- Find out the possible reasons for not making use of TPM in the SMEs identified.

2. **Sample Size (Overall):** The questionnaire was circulated to 160 respondents of different SMEs and 126 responses were obtained. The distribution of questionnaire was done using Google forms. Table 1 provides the description of the sample size (overall). The response received was convincing and found to be sufficient for further analysis. Fig.1 shows the distribution of sample size (overall) of the study.

Table 1: Description of the Overall Sample Size

Description	Total No. of SMEs
Questionnaires issued	160
Responses accepted	126
Response percentage	79

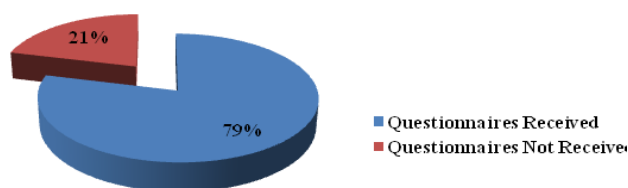


Figure 1: Sample size (overall) distribution

3. Tpm Usage and Level of Computerization in Smes: The responses obtained from the respondents are analyzed using statistical tools to draw inferences. The responses associated with the usage of TPM and those related to the level of computerization in the SMEs are tabulated in Table 2. Fig. 2 illustrates the extent of TPM usage in selected SMEs.

Table 2: Usage of TPM and Level of Computerization in the Selected SMEs

Q. No.	Questionnaire	Small & Medium Sized Enterprises		
		Yes	No	Total
1	TPM is being used in our SME	41	85	126
2	There is no computerization in our SME	19	66	85

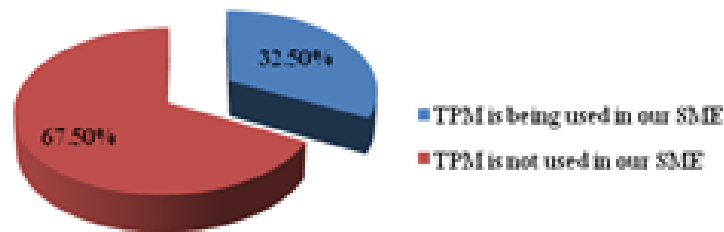


Figure 2: Extent of TPM usage in the selectes SMEs

It can be seen from Fig. 2 that a very less percentage (32.5%) of SMEs are using TPM as a performance improvement strategy. It has been observed that preventive and condition based maintenance are used by majority of the SMEs and few SMEs are still following the breakdown maintenance. A major percentage of the SMEs (67.5%) are not using TPM due to lack of awareness about TPM and its benefits. Therefore the analysis must be concentrated on these 85 industries in order to identify the potential reasons for not making use of TPM. It is also observed from the Table 2 that 66 SMEs out of 85 are having computerization in them. This reveals that, there is usage of computers in these SMEs, but the activities in the SMEs are not computerized. Hence it is essential to build-up the computerization of SME activities and create awareness of computer practice and its prospective benefits. The level of computerization in SMEs is presented in Figure 3.

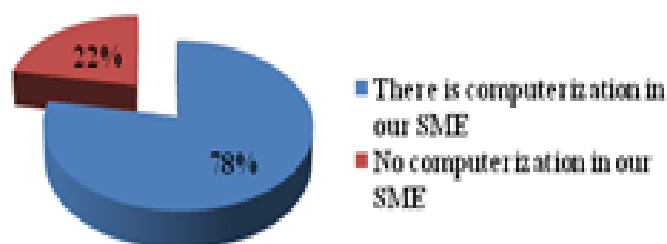


Figure 3: Level of computerization in the selectes SMEs

IV. TPM AWARENESS IN THE SELECTED SMES

TPM is a key strategy to enhance the performance and productivity of SMEs. To know the awareness level of TPM, a question was included in the questionnaire and the respondents were requested to respond to it. The responses obtained are shown in Table 3 and their pictorial representation is in Figure 4.

Table 3: TPM Awareness in the Selected SMEs

Q. No.	Questionnaire	SMEs		
		Yes	No	Total
3	We are heard and aware of TPM	45	40	85

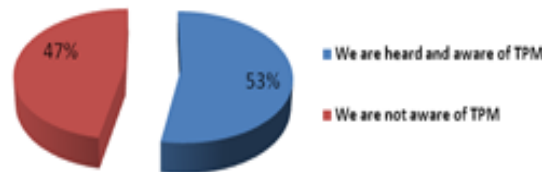


Figure 4: TPM awareness in the selected SMEs

It is observed (Fig. 4) that percentage awareness and unawareness of TPM is very close to each other in the selected SMEs. Therefore SMEs must be made aware that TPM is not limited to large enterprises only, it can be easily implemented in SMEs also.

- 1. Influence of Management on TPM Implementation:** Involvement, initiation and support from management are very crucial for the effective execution of TPM in any organization. Management should motivate its employees to take part actively in TPM implementation. Two important questions related to the influence of management on TPM implementation and their responses on a 5-point Likert scale are listed in Table 4.

Table 4: Influence of Management on TPM Implementation in the SMEs

Q. No.	Questionnaire	SMEs (Total 85)				
		Likert Scale rating				
		5	4	3	2	1
4	Management will not support/participate in implementing TPM in our SME.	4	18	31	23	9
5	Management may not encourage its employees by suitable rewards for their hard work and efforts in implementing TPM.	6	28	23	25	3

It is observed from Table 4 that the management’s participation, support and stimulus to its employees in implementing TPM are not copious in the selected SMEs. A certain percentage of respondents remained neutral to these questions as they are related to their management. Hence it is required to create awareness among these managements about the TPM concept and the benefits that could be obtained by its implementation.

- 2. Influence of Finance on TPM Implementation:** Finance has a great influence on TPM implementation. Large investments are necessary at various stages of TPM execution and the managements must be in a position to invest this amount in order to get attractive returns in terms of better-quality productivity, reduced defects, better product quality, lesser breakdowns, improved morale and skills of the employees, etc. Table 5 shows the questions associated with the finance in TPM implementation and their responses on a 5-point Likert scale.

Table 5: Influence of Finance on TPM Implementation in SMEs

Q. No.	Questionnaire	SMEs (Total 85)				
		Likert Scale rating				
		5	4	3	2	1
6	Financial limit is a reason for the non-usage of TPM in our SME.	4	13	33	23	12
7	TPM implementation needs large investments on training at various management levels.	5	41	26	13	0
8	TPM cannot be used in our SME due to its expensive nature.	2	14	43	26	0
9	TPM implementation will not provide immediate returns on the investments.	2	34	34	15	0
10.	Management may not accept the increased manpower costs generated as a result of TPM implementation.	3	27	35	19	1

From Table 5 it can be noted that quite a decent number of SMEs are conscious of the financial requirement in TPM implementation process. Their management has no financial constraints in TPM implementation. Also, they are conscious of the fact that TPM needs large expenditures for training at various stages and the money invested during TPM implementation will not yield the returns immediately. It is to be noted that more than 30% of the respondents were remained neutral to all the above five questions related to the finance in TPM implementation. This indicates that they are unaware of the influence of financial factor in TPM implementation and even they are unaware of the financial position of their management. These neutral respondents must be made conscious about the costs connected with the TPM and its execution.

- 3. Influence of Workforce Skills and Work Culture on TPM Implementation:** Every organization has a definite work culture involving clearly defined set of activities and the employees will be adjusted to it. They normally resist whenever there is a change in this routine work culture. But TPM implementation needs a total change in the work culture of the employees. It demands continuous updation in the skills and abilities of every

employee without offering any resistance to this change. Also they must develop the capability of working as a team since TPM works on network strategy. Table 6 shows the questions associated with the influence of workforce skills and work culture in TPM implementation and their responses.

Table 6: Influence of Workforce Skills and Work Culture on TPM Implementation in the Selected SMEs

Q. No.	Questionnaire	SMEs (Total 85)				
		Likert Scale rating				
		5	4	3	2	1
11	We lack supervisory and employee skills to implement TPM in our SME.	6	24	20	30	5
12	We are satisfied with the current work system and do not need any changes.	13	27	17	22	6
13	Employee skills need to be improved and updated continuously during TPM implementation.	17	48	19	1	0
14	TPM work TPM works on network strategy.	7	35	39	3	1
15.	It is not easy to collaborate the workforce at various management levels.	8	34	14	25	4

With reference to Table 6, the respondents are conscious about the fact that TPM works on network strategy and the employees need to upgrade themselves during TPM implementation. They are also conscious that, it not easy to have a collaboration of the workforce at various management levels. Majority of the SMEs do not lack the supervisory and workforce skills to implement TPM. But it can be seen that employees exhibit resistance for the change in the existing work system. Hence in order to shift from the existing work system to TPM, it is very much essential to educate and motivate the employees about TPM and its potential benefits.

4. Miscellaneous Factors Affecting Tpm Implementation: Miscellaneous factors affecting TPM implementation are shown in Table 7. More than 50% of the respondents feel that TPM is not supreme and it cannot satisfy all the needs of an organization. They are aware of the fact that TPM necessitates computer based documentation of maintenance activities, which can be retrieved for future use. About 59% of the SMEs have proper maintenance records which are helpful in determining the performance effectiveness of the machine or process, based on which TPM implementation can be planned. Some SMEs have another misconception that TPM will work satisfactorily only for large scale industries and it is not beneficial to SMEs. Both misconceptions (Q. No. 16 and 17) can be eliminated by conducting awareness sessions on TPM benefits. Table 7 also reveals that SMEs are facing difficulties in choosing a particular TPM tool for implementation. Many TPM tools are available and selecting a best possible tool for implementation requires experience and knowledge. Therefore it is a *primary requisite* to organize training sessions for TPM tool selection.

5. Finding The Most Influencing Factor For The Non-Usage Of TPM In The Smes: To find out the most influencing factor for the non-usage of TPM in the SMEs, Average and Standard Deviation of the response ratings are found for each TPM non-usage reason. These values are tabulated in Table 8. Questions 1 to 3 are with Yes/No response type and their responses are not rated on 5-point Likert Scale. Hence the Table 8 includes questions from 4 to 20.

Table 7: Miscellaneous Factors Affecting TPM Implementation in the Selected SMEs

Q. No.	Questionnaire	SMEs (Total 85)				
		5-Point Likert Scale				
		5	4	3	2	1
16	TPM is not ultimate for any organization.	5	40	28	12	0
17	TPM is favorable only to large scale industries.	6	28	24	27	0
18	TPM requires a strong computerized management system for recording the maintenance activities.	6	53	18	7	1
19	We can't implement TPM in our SME due to the absence of proper maintenance records.	4	17	14	39	11
20	Confusion in selecting a specific TPM tool makes it difficult to implement.	1	24	43	16	1

The reasons with average values more than 3 influence for the non-usage of TPM in the selected SMEs and are given in the Table 8 i.e. reasons with Question Nos. 5, 7, 9, 10, 12, 13, 14, 15, 16, 17, 18 and 20. The reason with question No. 13 is having maximum average response rating of 3.95 and is the main contributing factor for the non-usage of TPM. The reasons with average values less than 3 have lesser or no influence on the non-usage of TPM and they are with question Nos. 4, 6, 8, 11 and 19.

Table 8: Possible Reasons for the Non-implementation of TPM in the Selected SMEs

Q. No.	Questionnaire (Reasons for non-usage of TPM)	SMEs (Total 85)	
		Average	Std. Dev.
4	Management will not support/participate in executing TPM in our SME.	2.82	1.037
5	Management may not inspire their workforce by suitable reward systems for their efforts in implementing TPM.	3.10	1.023
6	Finance is a constraint for the non-usage TPM in our SME.	2.69	1.047
7	TPM implementation needs huge investments for training at various management levels.	3.45	0.824
8	TPM cannot be used in our SME due to its expensive nature.	2.91	0.750

9	Money invested during TPM implementation will not yield the returns immediately.	3.27	0.778
10	Management may not accept the increased manpower costs generated as a result of TPM implementation	3.14	0.847
11	We lack supervisory and employee skills to implement TPM in our SME.	2.95	1.079
12	We are satisfied with the current work system and do not need any changes.	3.22	1.199
13	Employee skills need to be improved and updated continuously during TPM implementation.	3.95	0.688
14	TPM works on network strategy.	3.52	0.750
15	It is not easy to collaborate the employees at various levels of management.	3.20	1.110
16	TPM is not ultimate for any organization.	3.45	0.809
17	TPM is favorable only to large scale industries.	3.15	0.958
18	TPM requires a strong computerized management system for recording the maintenance activities.	3.66	0.780
19	We can't implement TPM in our SME due to the absence of proper maintenance records.	2.58	1.095
20	Confusion in selecting a specific TPM tool makes it difficult to implement.	3.09	0.750

6. Current Status And Future Plans Of TPM Implementation In The Selected Smes:
Two questions were added to the questionnaire to know the current status of TPM implementation and future plans to implement TPM in the selected 85 SMEs. These two questions and their responses are shown in Table 9.

Table 9: Current Status and Future Plans of TPM Implementation in the Selected SMEs

Q. No.	Questionnaire	SMEs		
		Yes	No	Total
21	Whether TPM implementation is currently in progress in your SME?	14	71	85
22	Any future plans of TPM implementation in your SME?	28	43	71

It can be seen from Table 9 that, the TPM implementation is currently in progress only in 14 SMEs out of 85, which is about 16% only. The remaining 71SMEs are yet to start the implementation of TPM. This indicates that the SMEs are not making an attempt to implement TPM and obtain its potential benefits. This may be due to the lack of knowledge and expertise in TPM. It is also observed that 28SMEs out of 71 are planning to implement TPM in near future. Thus a few SMEs are realizing the importance of TPM, which is a good sign. The remaining 43SMEs are yet to take an initiation to implement TPM in them. Fig.5 and Fig. 6 shows the current status and future plans of TPM implementation in these SMEs.

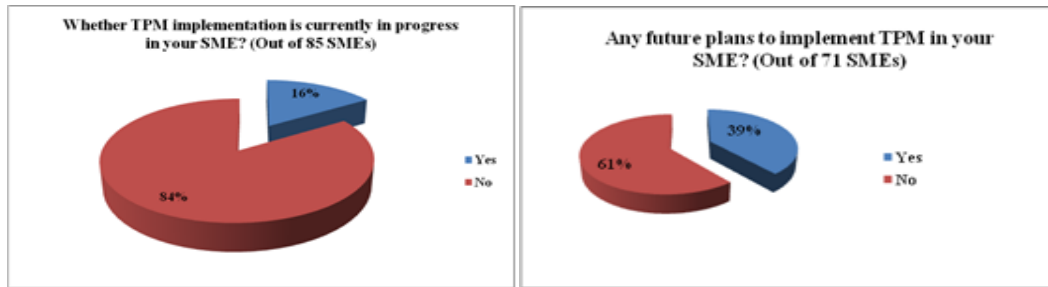


Figure 5: Current status of TPM implementation **Figure 6:** Future plans of TPM implementation

V. CONCLUSION

TPM collaborates maintenance and operation functions of any organization. It is a proactive approach to maintenance management and helps in improving the productivity of an equipment or a process. It enhances safe working environment, produces goods of high quality and reduces downtime of the equipment to minimum.

This survey research is limited to small and medium sized enterprises (SMEs) involving manufacturing industries and non-manufacturing organizations such as service and process industries. The study has revealed the extent of TPM usage and also identified the reasons that influence the non-usage of TPM in the selected SMEs. It was found that TPM is used in 41 SMEs out of 126, which is about 32.5%. This shows that use of TPM concepts in the selected SMEs is not much appreciable. It is observed from the survey that most of the industries use preventive and/or condition based maintenance systems and a few SMEs are still practicing breakdown maintenance. These SMEs are to be motivated by creating awareness on TPM and its usage to achieve maximum benefits in the long run. According to this research, the factors contributed to the non-usage of TPM in selected SMEs include – huge amount of financial requirement in training at various levels, delayed returns for the invested capital, increased manpower costs during TPM implementation, lack of reward systems for the employees for their efforts in implementing TPM, employee resistance to change from the current work system, need to continuously improve and upgrade the employee skills in TPM, employee need to develop the skill of working in teams, difficulties in collaborating the employees at different levels, need of a very strong computerized management system for recording maintenance activities, confusion in the selection of a particular TPM tool during implementation and the misconception that TPM is not beneficial to SMEs and is not ultimate for any SME. These factors are identified with the average response rating values more than 3 in Table 8. TPM can be implemented organization-wide and does not give immediate returns for the invested capital. An extensive training is needed at different stages of TPM implementation to provide awareness and share knowledge among the employees.

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