A Survey Based Study to Ascertain the Contributing Factors for the Implementation of TPM in SMEs

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ABSTRACT

Maintenance is considered to be a key activity in any manufacturing industry to improve the performance of plant and machineries. Total Productive Maintenance (TPM), Total Quality Management (TQM), Lean Production, Six Sigma, Just-in-time (JIT) are some of the performance improving initiatives implemented by various manufacturing organizations. This paper highlights the extent to which TPM is being used in the selected Small and Medium sized Enterprises (SMEs). The research is carried out with the help of a questionnaire consisting of 22 questions related to TPM implementation. The respondents include 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 they constitute the sample size. The responses are rated on a 5-point Likert scale. The responses collected are analyzed with the help of statistical tools such as bar charts and pie diagrams, interpreted thoroughly and inferences are drawn. Analysis indicate that only 41 SMEs out of 126 are making use of TPM for improving their performance and remaining are yet to initiate the use of it. The research also identifies the possible reasons for not initiating the implementation of TPM in the selected SMEs.

Keywords— TPM, TQM, JIT, SMEs, Six Sigma, Likert scale, questionnaire, Statistical analysis.

# 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 implemented organization-wide in manufacturing, service or process 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]. 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. There is no need to implement all eight TPM pillars in a phased manner in case of SMEs. The number of pillars needs to be implemented in SMEs is relatively less than those compared to large scale enterprises. Hence TPM can be effectively implemented in SMEs as well [15].

# METHODOLOGY

This quantitative research is carried out with the help of 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 respondents of the selected SMEs to check the ability 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 required for the research. Using Google forms the questionnaire was distributed to 160 respondents of different SMEs involving manufacturing and non-manufacturing organizations in India and abroad. The number of responses received was 126 (sample size). The responses obtained were rated on a 5-point Likert scale where 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 study 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.

# 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.

## **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 such as executives, line engineers, supervisors and managers from 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 questionnaire was designed in order 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 selected SMEs.

B. **Overall sample size**

The questionnaire was distributed to 160 respondents of different SMEs and 126 responses were obtained. The distribution of questionnaire was done using Google forms. Table 1 gives the description of the overall sample size. The response received was convincing and found to be sufficient for further analysis. Fig. 1 shows the distribution of overall sample size of the study.

**Table 1: Description of the Overall Sample Size**

|  |  |
| --- | --- |
| Description | Total No. of SMEs |
| Questionnaires Issued | 160 |
| Responses Received | 126 |
| Percentage of Response | 79 |

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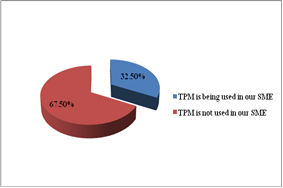
**Figure 1: Distribution of overall sample size**

C. **TPM usage and level of computerization in SMEs**

The responses obtained from the respondents are analyzed using statistical tools to draw inferences. The responses related to the usage of TPM and those related to the level of computerization in the selected SMEs are tabulated in Table 2. Fig. 2 shows the extent of TPM usage in selected SMEs.

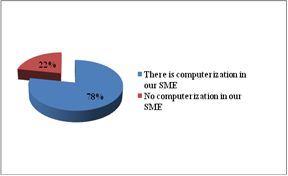
**Table 2: Usage of TPM and Level of Computerization in the Selected SMEs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 possible reasons for not making use of TPM. It is also observed from the Table II that 66 SMEs out 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 necessary to build-up the process of computerization of SME activities and create awareness of computer usage and its potential benefits. The level of computerization in the selected SMEs is shown in Fig. 3.



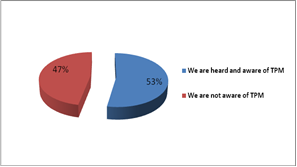
**Figure 3: Level of computerization in the selectes SMEs**

## **TPM awareness in the selected SMEs**

TPM is one of the key strategies to improve the performance and productivity of SMEs. To know the awareness level of TPM, a question was added in the questionnaire and the respondents were requested to respond to it. The details of the responses obtained are shown in Table 3 and represented diagrammatically in Fig. 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 selectes SMEs**

It is observed from 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 scale enterprises only, it can be easily implemented in SMEs also.

## **Influence of Management on TPM implementation**

Involvement, initiation and support from management are very crucial for the effective implementation 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 Selected SMEs**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Q. No. | Questionnaire | SMEs (Total 85) | | | | |
| 5-Point Likert Scale | | | | |
| 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 self-involvement, support and motivation to its employees in implementing TPM are not much appreciable 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.

## **Influence of finance on TPM implementation**

Finance has a great influence on TPM implementation. A large amount of money is required at various stages of TPM implementation and the managements must be in a position to invest this amount in order to get attractive returns in terms of improved productivity, reduced defects, better product quality, lesser breakdowns, improved morale and skills of the employees, etc. Table 5 shows the questions related to finance factor in TPM implementation and their responses on a 5-point Likert scale.

**Table 5: Influence of Finance on TPM Implementation in the Selected SMEs**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Q. No. | Questionnaire | SMEs (Total 85) | | | | |
| 5-Point Likert Scale | | | | |
| 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 amount of money for training at various levels of management. | 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 will not give immediate returns for the money invested during its implementation. | 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 good number of SMEs are aware of the financial requirement in TPM implementation process. Their management has no financial constraints in TPM implementation. Also, they are aware 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 aware of the costs associated with the TPM and its implementation.

## **Influence of workforce skills and work culture on TPM implementation**

Employees in an organization will be adjusted to a work culture involving clearly defined set of activities. 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 related to 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) | | | | |
| 5-Point Likert Scale | | | | |
| 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 works on network strategy. | 7 | 35 | 39 | 3 | 1 |
| 15. | It is not easy to collaborate the employees at various levels of management. | 8 | 34 | 14 | 25 | 4 |

With reference to Table 6, the respondents are aware of the fact that TPM works on network strategy and the employees need to upgrade themselves during TPM implementation. They are also aware that, it not easy to bring together the workforce at various levels of management. Most of the SMEs do not lack the supervisory and workforce skills to implement TPM. But it can be seen that employees show resistance for the change in the current 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.

## **Miscellaneous factors affecting TPM implementation**

Miscellaneous factors affecting TPM implementation are shown in Table VII. 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 selecting a particular TPM tool for implementation. Many TPM tools are available and selecting a best possible tool for implementation requires experience and knowledge. Hence it is necessary to organize training sessions for TPM tool selection.

## **Finding the most influencing factor for the non-usage of TPM in the selected SMEs**

To find out the most influencing factor for the non-usage of TPM in the selected SMEs, average and standard deviation of the response rating are found for each TPM non-usage reason. These values are tabulated in Table 8.

**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 beneficial 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 non-availability of proper maintenance records. | 4 | 17 | 14 | 39 | 11 |
| 20 | Confusion in selecting a particular TPM tool makes it difficult to implement. | 1 | 24 | 43 | 16 | 1 |

**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 implementing TPM in our SME. | 2.82 | 1.037 |
| 5 | Management may not encourage its employees by suitable rewards for their hard work and efforts in implementing TPM. | 3.10 | 1.023 |
| 6 | Financial limit is a reason for the non-usage TPM in our SME. | 2.69 | 1.047 |
| 7 | TPM implementation needs large amount of money for training at various levels of management. | 3.45 | 0.824 |
| 8 | TPM cannot be used in our SME due to its expensive nature. | 2.91 | 0.750 |
| 9 | TPM will not give immediate returns for the money invested during its implementation. | 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 beneficial 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 non-availability of proper maintenance records. | 2.58 | 1.095 |
| 20 | Confusion in selecting a particular TPM tool makes it difficult to implement. | 3.09 | 0.750 |

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 VIII 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 highest average response rating of 3.95 and is the main contributing factor for the non-usage of TPM. These contributing factors for TPM non-usage in the selected SMEs are shown in Fig. 5. 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.



**Figure 5: Contributing factors for TPM non-usage in the selectes SMEs**

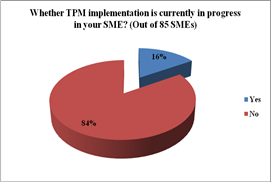
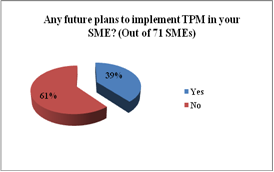
## **Current status and Future plans of TPM implementation in the selected SMEs**

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 71 SMEs 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 28 SMEs 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 43 SMEs are yet to take an initiation to implement TPM in them. Fig.6 and Fig. 7 shows the current status and future plans of TPM implementation in these SMEs.

**Figure 6: Current status of TPM implementation Figure 7: Future plans of TPM implementation**

# 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 maintenance and condition based maintenance systems and a few SMEs are still following breakdown maintenance. It is required to motivate these industries by creating awareness about TPM and its implementation to achieve long term benefits. 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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