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# TPM Strategies in Manufacturing SMEs of Punjab: An Empirical Investigation

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***ABSTRACT***

*The strategy of maintenance management of the equipment of a plant is very useful for the effectiveness of manufacturing system processes. The fast transforming global marketplace calls for influencing advancements in a company's implementation by focusing on boosting productivity levels, cost cutting, excellence and ensuring deliveries in order to satisfy clients. So, maintenance practices are required in the manufacturing companies. The potential influence of maintenance on the production execution is considerable. Equipment upkeep represents a major component of the operating cost in utilities, transportation, manufacturing and mining industries. This study has carried out manufacturing SMEs (small–medium enterprises) of Punjab to assess the performance of maintenance management strategies and practices. Questionnaire approach followed by quantitative analysis has been employed to ascertain the importance level. Filling and pilot testing of questionnaire has been done and final structured questionnaire has been sent to manufacturing companies of Punjab through random sampling from Punjab industrial directory. Reliability and descriptive statistics have been calculated using SPSS software, and results and conclusions are drawn from this quantitative modeling. TPM strategies and practices involved maintenance management approach. The result indicated that manufacturing organizations are highly focused on breakdown maintenance for carrying out maintenance management activities. Analysis of root cause is the most important quality maintenance technique for carrying out maintenance activities in the organizations, and maintenance management initiatives are significant predictors of maintenance management of continuous improvement. Conditions of 3Ms in the organization are the significant predictor of maintenance management practices in the companies of Punjab. Moreover, preparation of checklists for the planned maintenance is the most significant maintenance activity for carrying out TPM strategic implementation.*

***Keywords****: breakdown maintenance, maintenance management, manufacturing industry,TPM*

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## INTRODUCTION

The manufacturing organization has encountered an extraordinary level of change management over the most recent three decades, including extreme changes in the board approaches, process and

  

product advancements, expectations of customer, and competitive behavior [1]. Manufacturers have realized the need to continuously improve their operations to compete successfully. The global marketplace has witnessed an increased pressure from customers and competitors in manufacturing as well as the service sector [2]. The adjustments in the present business condition are described by extraordinary challenge on the inventory side and elevated unpredictability in customer requirement on the demand side [3]. These changes have left their unmistakable marks on the different facets of the manufacturing organizations [4]. Increase in customer demand, created by the procedure of steady change in the worldwide and national competitive condition, has influenced the manufacturing companies all around. Companies that need to get by in the present profoundly competitive business condition must address the requirement for top notch, lower costs, and progressively compelling and swifter Research and Development (R&D). The development of new technology, sophisticated high-production systems and assembly lines has ushered in a new era in manufacturing [5].

In the present fast-changing marketplace, gradual upgrades in manufacturing operations don't ensure the continued benefit or the survival of the company. Competitive pressures and changing production management standards, lately, have expanded the significance of solid and steady production equipments [6]. The ongoing competitive trends have been pushing manufacturing organizations to rethink the importance of expanding equipment efficiency and asset use, and of improving the quality and responsiveness of upkeep administrations to meet the association's objectives to accomplish world-class status [7]. Maintenance has traditionally been considered as a supporting, non-productive and non-value-adding function of a business. The maintenance function has typically been regarded as a necessary evil and an operating expense to be minimized and not treated as an investment in increasing the process reliability in many organizations [8]. An effective maintenance program can make significant contributions to production efficiency, plant availability, reliability and organizational profitability [9]. Presently, irrespective of the business domain, companies must focus on speed, efficiency and customer value to be globally competitive, and the long-term health of any organization depends on its commitment to continuous maintenance [10]. The aim of this study is to assess the performance of maintenance management practices in manufacturing SMEs of Punjab.

## LITERATURE REVIEW

Nakajima [11] has proposed a model called “Strategic Maintenance Quality Engineering” (SMQE) to make the theory of TPM exhaustive and suggested that scope of TPM could be enlarged and made more influential by mixing it with the contemporary incessant quality development model called “Statistical Quality Management” (SQM). The study reveals that the use of Information Technology (IT) for benchmarking SMQE can aid in improving strategic maintenance quality more effectively.

McKone et al. [12] have investigated the relationship between TPM and manufacturing performance through structural equation modeling. TPM has an optimistic and substantial connection with low cost (as measured by higher inventory turns), high stages of quality (as measured by higher levels of conformance to stipulations) and strong delivery performance (as measured by higher percentage of on-time deliveries and faster

speeds of delivery). The results show that there is a positive relationship between TPM and manufacturing performance through JIT practices.

Sangameshwran and Jagannathan [13] have reported that the essence of TPM is business process improvement through working teams, cutting across organizational layers. The study reports that TPM has immensely helped Hindustan Lever Limited (HLL), India's largest FMCG company, by changing itself internally to give itself a long-term competitive advantage in manufacturing. They further add that TPM is the only business initiative where returns have been 8–12 times that of investments. It has been reported that TPM costs and benefits for various HLL plants over the three-year period included Silvassa PP Plant – Investment (Rs. 1.50 Crores) and Benefits (Rs. 21 Crores); Orai Plant – Investment (Rs. 0.45 Crores) and Benefits (Rs. 6.0 Crores); and Rajpura Plant – Investment (Rs. 0.42 Crores) and Benefits (Rs. 6.20 Crores). This clearly demonstrates the true potential of TPM in a proactive Indian organization.

Seth and Tripathi [14] have investigated strategic implications of TQM and TPM in an Indian manufacturing set-up. They have examined the relationship between factors influencing implementation of TQM and TPM initiatives with business performance, for the following three approaches in an Indian context: TQM alone; TPM alone; both TQM and TPM together and have also extracted significant factors for the above three approaches. The research identifies critical significant factors like leadership; process management and strategic planning; equipment management and focus on customer satisfaction, for the effective adaptation of TQM and TPM programs in Indian manufacturing environment.

## RESEARCH DESIGN, RESEARCH INSTRUMENT AND RESEARCH METHODOLOGY

For this survey, a questionnaire has been prepared which consists of four different sections. The first section consists of questions related to importance level of maintenance management strategies, and importance level of other maintenance management practices has been designed on the scale (1 = Not at all important**;** 2 **=** To a small extent; 3 = To a moderate extent; 4 = To a large extent). The questionnaire has been pre-tested for content ambiguity and clarity by experienced managers of G.S. Auto International Ltd of Punjab. The research methodology for the present work is as follows:

- Exhaustive literature review
- Formulation of problem
- Generation of questionnaire
- Testing of the questionnaire
- Quantitative analysis
- Role of maintenance management strategies and practices
- Results and conclusions

The manufacturing SMEs are selected randomly from Punjab Industrial Directory and filling of questionnaire has been done on snow-ball sampling technique/convenience sampling technique. The questionnaire has been sent to 100 companies and responses of 23 companies have been obtained representing the response rate of 23%. Descriptive statistics and reliability have been measured using SPSS software.

## RESULTS AND DISCUSSION

### Reliability and Descriptive Statistics

The reliability coefficient/Cronbach's alpha has been calculated for different maintenance management strategies and practices. The importance level of these strategies has been calculated from mean, and reliability has been measured from the

value of Cronbach's alpha. Table 1 shows the descriptive statistics and *t*-statistics for strategies.

***Table 1.*** *Level of importance of maintenance management strategies.*

| **Strategies** | **Mean** | ***t*-Statistics** | **Cronbach's alpha** |
|---|---|---|---|
| Preventive maintenance | 3.347826 | 8.339428 | 0.78 |
| Breakdown maintenance | 3.695652 | 10.63237 | |
| Predictive maintenance | 3.173913 | 8.657016 | |
| Autonomous maintenance | 3.043478 | 5.127422 | |
| Mobile maintenance | 3 | 4.591659 | |
| Corrective maintenance | 3.304348 | 8.899438 | |
| Computerized maintenance management | 2.913043 | 4.612626 | |
| Reliability-centered maintenance | 2.826087 | 5.526858 | |
| **Critical value of *t* = 2.074** | | | |

## RESULT DISCUSSION OF FINDINGS 1

The reliability coefficient of maintenance management strategies is adequate for operations management research {Value of reliability should be greater or equal to 0.7 [2]}. The calculated values of *t* are greater than the critical value of *t*, which signifies all values are significant and claims are justified. Further results indicated that breakdown maintenance is rated the most important strategy of maintenance management followed by preventive maintenance, corrective maintenance, predictive maintenance, mobile maintenance, computerized maintenance management and reliability-centered maintenance.

### *Level of Importance of Maintenance Management Practices*

Again, descriptive statistics and *t*-stat have been calculated for maintenance management practices. Table 2 shows the descriptive statistics calculated for different maintenance management practices in terms of main practices.

***Table 2.*** *Level of importance of maintenance management practices.*

| **Practices** | **Mean** | ***t*-Statistics** |
|---|---|---|
| *Planned Maintenance* | | |
| Planning efficient and effective PM, PdM and TBM systems over equipment life cycle | 3.086957 | 7.109956 |
| Establishing PM check sheets | 3.434783 | 10.3884 |
| Improving MTBF and MTTR | 3.043478 | 7.843122 |
| *Quality Maintenance* | | |
| Achieving zero defects | 3.434783 | 13.57543 |
| Tracking and addressing equipment problems and root causes | 3.478261 | 10.65531 |
| Setting 3M (machine/man/material) conditions | 3.478261 | 11.95309 |
| *Development Management* | | |
| Minimal problems and running in time on new equipment | 3.173913 | 7.853955 |
| Utilize learning from existing systems to new systems | 3.130435 | 7.161198 |
| Maintenance improvement initiatives | 3.26087 | 7.46518 |
| **Critical value of *t* = 2.074** | | |

## RESULTS DISCUSSION OF FINDINGS 2

The sample statistics for all practices is significant since the value of calculated *t* is greater than the critical value of *t*. The results indicated that the establishment of preventive maintenance checklist is rated the most important in terms of planned maintenance followed by planning efficient and effective PM, PdM and TBM systems over equipment life cycle and improving MTBF and MTTR; in terms of quality maintenance, setting 3M (machine/man/material) conditions and tracking and addressing equipment problems and root causes are rated most important followed by achieving zero defects; maintenance improvement initiatives are rated most important in terms of development management followed by minimal problems and running in time on new equipment and utilize learning from existing systems to new systems.

## CONCLUSIONS

From the results and discussion, it is concluded that preparation of checklists is

 

the most important planned maintenance activity for carrying out maintenance management. Root cause analysis of maintenance problems is significantly important quality maintenance activity for carrying out maintenance practices effectively. Setting condition of 3Ms for carrying out quality maintenance is the most improvement maintenance management practice. Development of maintenance management initiatives taken by the manufacturing SMEs plays a significant role in carrying out development management in the organizations. Maintenance after breakdown is significantly employed by manufacturing industry of Punjab. Breakdown maintenance practices are useful for implementing TPM strategies in the systematic manner in the companies of Punjab.

## LIMITATIONS

Since there is only one respondent from each organization, there is possibility of method variance. Moreover, the filling of questionnaire from the companies has been done on convenience sampling technique.

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