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Case Study

A Case Study Examining the Effects of Total Productive Maintenance on Performance Indicators in the Manufacturing Sector

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Abstract

A customized method to maintaining plants and equipment is known as total productive maintenance, or TPM. This type of maintenance program ensures optimal availability, equipment effectiveness, and the development of an autonomous maintenance culture. In the context of the two-wheeler automotive industry, the purpose of this article is to demonstrate the notable increases in operational efficiency with respect to TPM key performance indicators, or productivity (P), quality (Q), cost (C), delivery (D), safety (S), and morale (M), collectively referred to as "PQCDSM." The practical advantages of TPM key performance measures have been the study's main focus. The findings demonstrate that the chosen auto plant significantly improved production output, customer complaints, operating costs, accident frequency, and employee morale within the three-year target timeframe. The research's conclusions show that systematic TPM interventions significantly improved the "PQCDSM" metrics, which in turn encouraged the workforce to participate in improvement initiatives. The intangible results attained by applying TPM were a significant area of investigation from this study.

Keywords: *Total Productive Maintenance, Productivity, Maintenance Manufacturing, Reliability*

1. Introduction

Increased market competitiveness, growing demands for timely, high-quality products at competitive rates, and faster delivery times have resulted from the manufacturing systems' automation, integration, and adaptability. Plant efficiency is constantly reduced by downtime failure, and maintenance and operational expenses rise as a result. Because of this, it is imperative to create and implement an overall maintenance planning system that integrates resources and looks into the causes of failures. As a result, total productive maintenance, or TPM, has emerged as one of the most cutting-edge maintenance techniques and a successful strategy to raise a plant's overall efficiency over the course of its lifetime through employee engagement and motivation. The father of TPM, [14] described it as a novel approach to maintenance that maximizes equipment efficiency, prevents malfunctions, and encourages self-sufficient maintenance through routine tasks involving the whole staff. According to [1], a well-crafted TPM implementation plan not only enhances the effectiveness and efficiency of equipment but also yields noticeable benefits in other domains like decreased manufacturing cycle time, inventory size, and customer complaints.

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It also fosters the formation of cohesive small group autonomous teams and boosts individual skill and confidence. [2] came to the conclusion that TPM is a difficult endeavor that is hampered by departmental, organizational, cultural, behavioral, technological, operational, and budgetary obstacles. In their comprehensive case study, [11] noted the material and immaterial advantages gained at various phases of TPM implementation in an auto-sector industry. That was covered by [6]. Since there is a final shift in people's knowledge, abilities, and behavior throughout the process, a successful TPM implementation produces better and more persistent results than other separate programs. From the perspective of researchers and practitioners, [10] offered a summary of the TPM implementation strategies used by different manufacturing organizations and identified any potential shortcomings. Total productive maintenance's benefits to enhancing manufacturing performance in Ethiopia's malt production sector were assessed by [15]. The experimental investigation of overall equipment effectiveness (OEE) in different machines and its development plan through TPM was reviewed by [8].

The investigation led to the conclusion that the primary goal of the researchers was to improve OEE in any manufacturing or production organization through the scientific and systematic application of TPM. The

evaluation and enhancement of production productivity performance in an agile manufacturing organization was the main emphasis of [3]. Today's organizations need to be flexible enough to implement mass customization, and in light of that flexibility, their operations need to be extremely well-fitted in terms of metrics measuring productivity, quality, cost, delivery, safety, and motivation. Because measuring each indicator keeps everyone interested in tracking and improving these indicators, it is highly vital. The aim of the cross-functional team formed by TPM is to generate proposals for improvement while addressing all facets of performance indicators.

2. TPM Key Indicators

a) Productivity (P): Production output lost as a result of inefficient labor, inefficient materials, and inefficient tools. Standard TPM requirements state that an OEE of at least 85% must be attained.

b) **Quality (Q):** To receive no complaints from customers. This can be achieved by removing rejection and rework, as well as by preventing errors in the creation of bills, invoices, and checks. In larger terms, it refers to exceeding consumer expectations in order to prevent client returns.

c) **Cost (C):** To achieve a 30% reduction in production costs through inventory carrying, maintenance, operation, and communication costs, among other things.

d) **Delivery (D):** To provide the client with 100% of the goods on schedule. It can be accomplished by reducing the amount of time that logistic losses and delivery delays to any support functions take.

e) **Safety (S):** By guaranteeing worker safety on machinery, material handling safety, packing safety, etc., we can establish a zero accident zone.

f) **Morale (M):** encouraging staff members to contribute several kaizens, or one point lessons (OPL), in order to strengthen the organization. It also entails the creation of independent maintenance groups in an effort to foster improved cooperation and communication.

Table1: PQCDSM-Improvements for early TPM Implementation in Japan [12]

- **P – Productivity:**
  Net productivity up by 1.5 to 2.0 times.
  Number of equipment breakdowns reduced by 1/10 to 1/250 of baseline.
  Overall plant effectiveness 1.5 to 2.0 times greater.
- **Q – Quality:**
  Process defect rate reduced by 90%.
  Customer returns/claims reduced by 75%.
- **C – Cost:** Production costs reduced by 30%.
- **D – Delivery:** Finished goods and Work in Progress (WIP) reduced by half.
- **S – Safety.**
  Elimination of shutdown accidents.
  Elimination of pollution incidents.
- **M – Morale:** Employee improvement suggestions up by 5 to 10 times.

3. Case Study Objective

This chapter presents a case study of a two-wheeler automotive manufacturing sector in North India, which is the largest motorbike producer in the nation. Because of the TPM implementation, the industry that was chosen for this project has effectively adopted TPM efforts and won the TPM excellence award. The aim of this chapter is to demonstrate how successfully implementing TPM can significantly increase operational efficiency in terms of performance quality data indicators and Intangible results attained by using TPM were a significant area of investigation from this study.

4. Impact of TPM on Performance Indicators

4.1 Impact of TPM on Productivity

TPM aims to maximize plant output in terms of PQCDSM while minimizing input in order to maximize total plant efficiency. The OEE of the TPM manager model machine in the machining department was first assessed, but it was gradually copied in other areas.

The application of 5S in workplaces and retail spaces has also significantly increased worker productivity. In order to raise the plant's total productivity, it assisted in inspiring the staff to actively participate in and contribute to tasks linked to production and maintenance.

4.2 Impact of TPM on Quality

Regarded as one of the most promising factors in creating a brand's image is quality. Defects, rework, and customer rejections all significantly affect the quality indicator. It was noted that there were much fewer client complaints. This has been made possible by consistently tracking and resolving customer-focused issues. The approach of streamlining the processes from the start has also been used to ensure that no faulty products were produced. There has been a decrease in customer complaints as a result of the office TPM pillar and 5S strategy, which have automatically enhanced worker efficiency in support tasks like making checks and invoices.

4.3 Impact of TPM on Cost

When it comes to enhancing the organizations' operational performance, TPM has proven incredibly effective. According to [17], a TPM program enhanced production flow, decreased operating costs, and increased product quality, losses etc. TPM also strives for sustained and long-term performance gains, which enhances an organization's financial output in terms of earnings and market share. [16] came to the conclusion that TPM might be the main driver of manufacturing companies' profitability.

4.4 Impact of TPM on Delivery

The reputation of the company and customer satisfaction may suffer from late or erroneous deliveries. Delivery adherence increased dramatically, rising from 75% to 96%.

However, following TPM initiatives, the logistics section has improved in relation to loading and unloading issues, resolving labor or raw material shortages, and transportation issues, allowing the delivery adherence to reach 96%.

4.5 Impact of TPM on Safety

The core tenets of TPM include ensuring equipment dependability, maintainability, human safety, and the eradication of pollution and accidents. For this reason, a key element of any TPM development program is the safety, health, and environment pillar.

Using TPM, it creates a clean, safe, and healthy work environment. The following unsafe conditions are the cause of unfortunate incidents and accidents in manufacturing organizations: poorly designed workspaces, inappropriately designed equipment and tooling, operator negligence, damaged instruments, ineffective equipment protection shields, absence of fire and explosion preventive systems, and unfavorable working conditions like noise and air pollution [4, 5, 7]

4.6 Impact of TPM on Morale

Numerous kaizens and absenteeism have been proven to be good indicators of staff morale in TPM adoption. Motivation is a key TPM indicator for sustaining the excitement and a good outlook throughout the duration. signs, banners, notice boards and TPM newsletter

To foster a good atmosphere and a strong workplace culture, many tools were used, including flags, notice boards, weekly publications, TPM posters placed in critical areas, and TPM slogan creation [13]. Motivation awards were awarded in office meetings or organization events to contributing employees and shifts, as noted by [9]. Effective human resource management practices motivate employees by pushing them to work harder and more intelligently. Thus, individuals who possess talents and are highly motivated and trained add to organizational performance.

5. Discussion and analysis of TPM Performance Indicators

It has been noted that a thorough cultural shift and a resolute commitment from top management are necessary for the sensible actualization of TPM initiatives at a chosen auto plant. The observable advantages each indication is quite significant and useful in understanding how TPM affects the organization. The favorable effects of TPM deployment in the automotive industry are emphasized by the real-life improvement in TPM effectiveness indicators (PQCDSM). The TPM journey has demonstrated notable and noteworthy advancements in equipment availability, product performance, and quality rate. It has also resulted in quantifiable improvements in other manufacturing areas within the organization. It is evident that TPM adoption aims to raise manufacturing output, quality, delivery, safety, employee morale by guaranteeing.

Additionally, intangible results from TPM implementation were noted. The many intangible outcomes that were noted included an increase in employee pride in their work environment and equipment, as well as an improvement in morale and a good attitude work, enhanced group dynamics and collaboration among operators and employees, all of which were valued contributions that received awards. TPM also aids in enhancing each employee's chosen plant core competency. It causes a beneficial shift in the operators' attitudes and working styles as well as an increase in the development of high confidence among the workforce.

Conclusion

The organization achieved a number of substantial benefits in the three-year target period, including a notable improvement in production volume, customer complaints, operational costs, accident rates, and employee morale. There was a remarkable rise in the average monthly production volume, which was discovered to be 78,442, but productivity improved as a result of TPM activities, and production volume jumped to 232,200. Improvements in OEE and the detection and removal of anomalies to autonomous maintenance have led to a decrease in breakdowns and failures and an increase in production volume. The number of consumer complaints has significantly decreased, going from 64 at baseline to 10 now. The amount of kaizen achieved increased dramatically from 320 to 6402, and the trend in absenteeism dropped from 15% to 0%. The plant's successful adoption of the 5S technique, the drop in accident rates, and the methodical approach all contributed to the rise in staff morale. For the organization to continue growing, the TPM philosophy should be implemented with a strong sense of teamwork.

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