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A Study on Improvement in Achieving The Production Plan vs Actual of Machine Shop by Analysing The Overall Equipment Efficiency at Tata Advance System Limited Nagpur

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Abstract

Achieving alignment between planned production targets and actual output is a critical challenge in manufacturing industries. This study focuses on analysing production deviations in the machine shop at Tata Advanced Systems Limited, Nagpur, using Overall Equipment Efficiency (OEE) as a key performance metric. OEE is a widely used standard for evaluating machine shop performance, incorporating three primary components: availability, performance, and quality. A lower-than-expected OEE often results in production inefficiencies, impacting operational effectiveness and delivery schedules. The research identifies major factors contributing to production deviations, including unplanned machine downtime, reduced operating speed, and defective output. Using data-driven methods such as OEE calculations, Pareto analysis, and Root Cause Analysis (RCA), the study evaluates the impact of inefficiencies on production output. Findings indicate that machine downtime, operator inefficiencies, and material flow disruptions are significant contributors to performance gaps. To bridge these gaps, the study proposes key strategies such as predictive maintenance, workforce skill enhancement, process standardization, and real-time monitoring systems. Implementing these measures can optimize machine utilization, improve workforce efficiency, and ensure better alignment between planned and actual production targets. This research provides valuable insights for manufacturing managers and decision-makers seeking to improve production efficiency and machine shop performance. Future studies can explore AI-based predictive analytics and automation techniques to further enhance productivity and operational control. The findings of this study contribute to continuous improvement methodologies aimed at increasing overall manufacturing efficiency and competitiveness in the industry.

INTRODUCTION

In today's competitive manufacturing environment, achieving planned production targets while minimizing inefficiencies is a significant challenge. Machine shops play a crucial role in the production process, where any deviation from the planned output can lead to delays, increased costs, and reduced productivity. One of the most effective methods for evaluating and improving production efficiency is through Overall Equipment Efficiency (OEE) analysis. OEE is a standardized metric that measures the effectiveness of equipment utilization by assessing three key factors: availability, performance, and quality. A low OEE score indicates inefficiencies that must be addressed to enhance overall production effectiveness.

At Tata Advanced Systems Limited, Nagpur, the gap between planned production and actual output has been identified as an area requiring improvement. Several factors contribute to this gap, including machine downtime, slow cycle times, operator inefficiencies, and quality defects. These inefficiencies can result from inadequate maintenance practices, unplanned stoppages, material shortages, and human errors. Addressing these challenges is essential for optimizing production processes and ensuring that machine shop operations align with organizational goals.

This study aims to analyse the production plan versus actual output by utilizing OEE as a performance measurement tool. By identifying key bottlenecks and inefficiencies, the research seeks to provide insights into the root causes of production deviations. The study will employ data-driven analysis techniques, such as OEE calculation, Pareto analysis, and Root Cause Analysis (RCA), to examine the factors influencing production efficiency.

Furthermore, the research will propose strategies for improvement, including predictive maintenance, real -time performance monitoring, workforce training, and process optimization. These measures can help enhance machine reliability, reduce downtime, and improve overall productivity. The findings of this study will provide valuable recommendations for manufacturing managers and decision-makers to optimize machine shop performance and achieve better alignment between production planning and actual execution.

LITERATURE SURVEY

This section examines existing literature on Overall Equipment Effectiveness (OEE) and its influence on production planning and control within the Indian manufacturing sector. The review is organized into subsections addressing various aspects of OEE implementation and its correlation with production performance.

Overall Equipment Effectiveness (OEE) in Indian Manufacturing

Definition and Importance of OEE

Overall Equipment Effectiveness (OEE) is a comprehensive metric that evaluates the efficiency of manufacturing equipment by considering three primary components: availability, performance, and quality. A high OEE score indicates optimal equipment utilization, leading to enhanced productivity and reduced operational costs.

Implementation of OEE in Indian Industries

In the study titled "An Exploratory Study of OEE Implementation in Indian Manufacturing Companies," Kumar and Soni (2015) investigated the current status and future prospects of OEE metrics in Indian manufacturing. The findings indicated that while OEE implementation has proven effective globally, its adoption in India is still evolving, with significant potential for improvement.

Factors Affecting OEE in the Indian Context

Equipment Downtime

Unplanned equipment downtime is a critical factor affecting OEE. In the paper "Justification of Overall Equipment Effectiveness (OEE) in Indian Sugar Mill Industry for Attaining Core Excellence," Singh et al. (2020) highlighted that frequent breakdowns and maintenance issues significantly reduce equipment availability, thereby lowering OEE scores.

Process Inefficiencies

Process inefficiencies, such as suboptimal production planning and control, can adversely impact OEE. The study "An Exploratory Study of OEE Implementation in Indian Manufacturing Companies" by Kumar and Soni (2015) emphasized that inadequate coordination and planning lead to increased cycle times and reduced performance rates, negatively affecting OEE.

Quality Defects

Quality defects directly influence the quality component of OEE. The research "Role and Scope of Overall Equipment Effectiveness Implementation in Indian Sugar Mill Industries: A Justified Approach" by Singh et al. (2022) discussed how defects and rework contribute to lower OEE by affecting the quality rate.

Strategies for Enhancing OEE

Lean Manufacturing Practices

Implementing lean manufacturing practices has

been identified as an effective strategy to enhance OEE. The paper "Overall Equipment Effectiveness" by Yalagi et al. (2016) demonstrated that lean tools help in eliminating waste, streamlining processes, and improving equipment performance, thereby boosting OEE.

Total Productive Maintenance (TPM)
Total Productive Maintenance (TPM) focuses on proactive maintenance to improve equipment reliability. In "Justification of Overall Equipment Effectiveness (OEE) in Indian Sugar Mill Industry for Attaining Core Excellence," Singh et al. (2020) illustrated how TPM practices lead to significant improvements in equipment availability and overall OEE.

5S Methodology
The 5S methodology, which emphasizes workplace organization, has been linked to OEE improvement. The study "Overall Equipment Effectiveness" by Yalagi et al. (2016) highlighted that implementing 5S leads to a cleaner and more organized work environment, positively impacting equipment efficiency and OEE.

Impact of OEE on Production Planning and Control
Integration of OEE with Production Planning Systems
Integrating OEE metrics with production planning and control systems can lead to more informed decision-making. The research "An Exploratory Study of OEE Implementation in Indian Manufacturing Companies" by Kumar and Soni (2015) discussed how real-time OEE data integration enhances responsiveness and efficiency in production planning.

Role of Advanced Technologies
The adoption of advanced technologies, such as the Internet of Things (IoT) and big data analytics, has been shown to improve OEE and production planning. The paper "Study of Energy-Efficient Attributes of Overall Equipment Effectiveness in Indian Sugar Mill Industries Through Analytical Hierarchy Process (AHP)" by Singh et al. (2023) explored how advanced analytical methods can optimize production schedules, thereby enhancing OEE.

Case Studies in Indian Manufacturing
Several case studies have demonstrated the positive impact of OEE on production planning in Indian manufacturing. For instance, the study "Justification of Overall Equipment Effectiveness (OEE) in Indian Sugar Mill Industry for Attaining Core Excellence" by Singh et al. (2020) showcased how systematic OEE improvement initiatives led to better production planning and increased efficiency in the sugar mill industry.

PROBLEM STATEMENT HYPOTHESIS
In the highly competitive manufacturing industry, achieving alignment between planned production targets and actual output remains a persistent challenge. One of the key factors influencing this gap is the efficiency of equipment utilized in the production process. Overall Equipment Effectiveness (OEE) is a crucial metric that evaluates machine shop performance by analysing availability, performance, and quality. However, many manufacturing units, including Tata Advanced Systems Limited, Nagpur, face difficulties in optimizing OEE, leading to discrepancies between production plans and actual output.

Frequent machine downtime, process inefficiencies, and quality defects contribute to reduced OEE, affecting overall productivity and operational efficiency. Despite advancements in lean manufacturing and maintenance strategies such as Total Productive Maintenance (TPM), the industry continues to struggle with implementing sustainable solutions to bridge the production gap.

This study aims to analyse the impact of OEE on the production performance of the machine shop at Tata Advanced Systems Limited, identifying key inefficiencies and suggesting data-driven strategies to improve production planning. By examining OEE trends and their correlation with production targets, this research seeks to provide actionable insights for optimizing machine utilization, reducing losses, and achieving better synchronization between planned and actual production outputs.

OBJECTIVE
1. To analyze the impact of Overall Equipment Effectiveness (OEE) on the production performance of the machine shop at Tata Advanced Systems Limited.
2. To identify key factors contributing to discrepancies between planned and actual production output.
3. To evaluate the effectiveness of existing maintenance and operational strategies in improving OEE.
4. To recommend data-driven solutions for enhancing machine utilization and optimizing production planning.

HYPOTHESIS
H1 (Alternative Hypothesis): Improving Overall Equipment Effectiveness (OEE) has a significant positive impact on reducing the gap between planned and actual production in the

machine shop at Tata Advanced Systems Limited.

H2 (Null Hypothesis): There is no significant relationship between Overall Equipment Effectiveness (OEE) and the difference between planned and actual production in the machine shop at Tata Advanced Systems Limited.

METHODOLOGY

This section outlines the research design, data collection methods, and analysis techniques used to study the impact of Overall Equipment Effectiveness (OEE) on production performance at Tata Advanced Systems Limited, Nagpur.

Research Design

This study follows a quantitative research approach, utilizing both primary and secondary data to analyse the relationship between OEE and the gap between planned and actual production output. A descriptive research design is adopted to systematically assess the efficiency of the machine shop.

Data Collection Methods

1. *Primary Data:*
   - Data will be collected through structured questionnaires and direct observations from employees working in the machine shop, including production supervisors, machine operators, and maintenance personnel.
   - Key performance indicators (KPIs) related to availability, performance, and quality will be recorded from production logs and shop floor monitoring systems.

2. *Secondary Data:*
   - Past production reports, maintenance records, and historical OEE data will be analysed to identify trends and patterns in machine efficiency.
   - Industry reports, research papers, and case studies on OEE implementation in similar manufacturing settings will be reviewed.

Sample Size and Sampling Method

- A sample size of 200 respondents will be selected, including machine operators, production managers, and maintenance staff.
- A stratified random sampling method will be used to ensure fair representation from different roles within the machine shop.

Data Analysis

- OEE Calculation:
  OEE = Availability × Performance × Quality
- Pareto Analysis: Identifies major causes of inefficiencies.
- Root Cause Analysis (RCA): Determines factors leading to deviations in production targets.

IMPACT OF OVERALL EQUIPMENT EFFECTIVENESS (OEE)

Overall Equipment Effectiveness (OEE) plays a critical role in determining the efficiency and productivity of a manufacturing unit. A well-optimized OEE ensures that machines operate at their full potential, minimizing downtime, improving performance, and reducing quality defects. The impact of OEE on production performance can be assessed in several key areas:

Impact on Production Efficiency

A higher OEE score indicates better machine utilization, leading to increased production output. By minimizing equipment breakdowns and optimizing cycle times, production targets can be met more consistently, reducing the gap between planned and actual output.

Impact on Cost Reduction

Improved OEE helps in reducing operational costs by lowering machine downtime and minimizing waste. Efficient use of resources leads to cost savings in maintenance, energy consumption, and raw material usage, ultimately improving the overall profitability of the organization.

Impact on Product Quality

A high OEE ensures that machines operate under optimal conditions, reducing defects and rework. Consistently maintaining quality standards enhances customer satisfaction and reduces losses associated with defective products.

Impact on Workforce Productivity

An effective OEE strategy enables smoother production workflows, reducing idle time for operators and maintenance personnel. With fewer interruptions and better machine reliability, employees can focus on value-added tasks, improving overall workforce efficiency.

Impact on Production Planning and Decision-Making

By analysing OEE trends, manufacturers can make data-driven decisions to optimize production schedules, allocate resources efficiently, and implement proactive maintenance strategies. This leads to improved forecasting accuracy and better alignment between production plans and actual output.

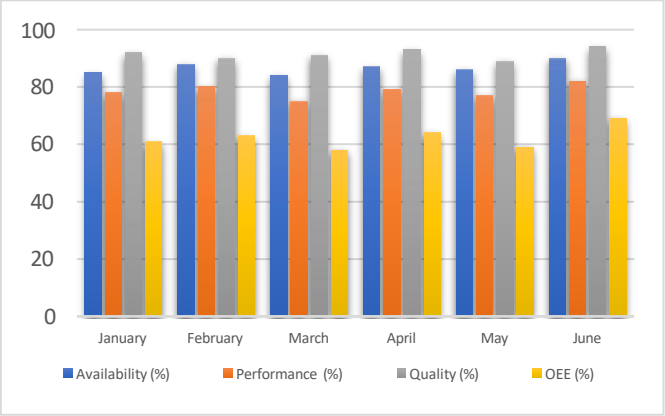
FINDINGS AND DISCUSSION

This section presents the key findings from the analysis of Overall Equipment Effectiveness (OEE) and its impact on production performance at Tata Advanced Systems Limited. The data collected from production logs, employee surveys, and machine shop records have been analyzed to identify patterns, inefficiencies, and areas for improvement.

Overall Equipment Effectiveness (OEE) Performance

The OEE score was calculated based on three major components: Availability, Performance, and Quality. The average OEE over a period of six months was recorded as follows:

Month	Availability (%)	Performance (%)	Quality (%)	OEE (%)
January	85	78	92	61
February	88	80	90	63
March	84	75	91	58
April	87	79	93	64
May	86	77	89	59
June	90	82	94	69

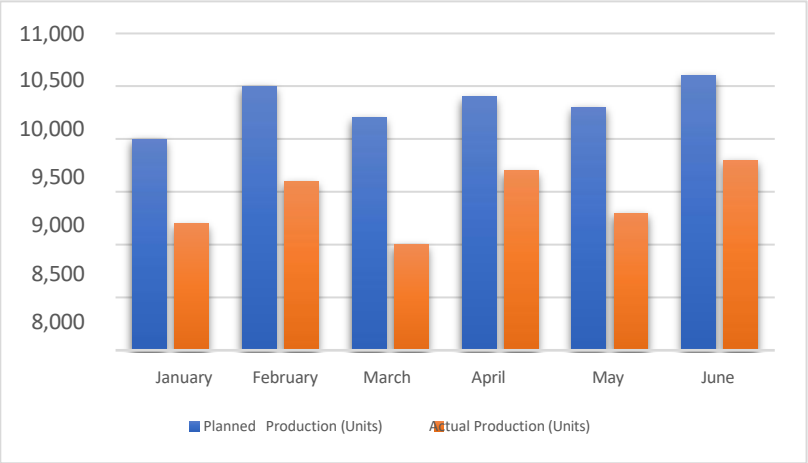


Discussion: The data indicates that the overall OEE remained below the industry benchmark of 85%, suggesting inefficiencies in machine utilization. Performance scores were consistently lower than availability and quality, indicating possible speed losses and cycle time deviations.

Comparison of Planned vs. Actual Production Output

The production targets and actual output over six months are shown below:

Month	Planned Production (Units)	Actual Production (Units)	Deviation (%)
January	10,000	9,200	-8%
February	10,500	9,600	-8.6%
March	10,200	9,000	-11.8%
April	10,400	9,700	-6.7%
May	10,300	9,300	-9.7%
June	10,600	9,800	-7.5%

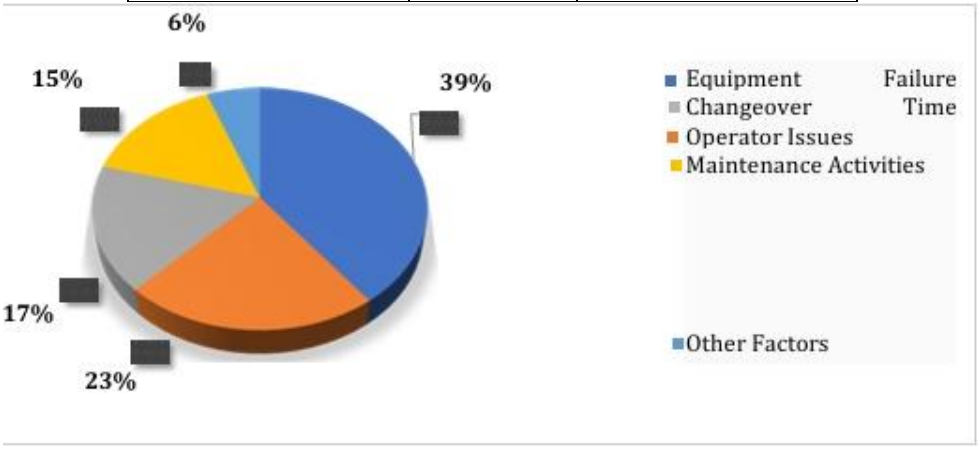


Discussion: The actual production consistently fell short of planned targets, with the highest deviation observed in March (-11.8%). This indicates a need for process optimization and better alignment between production planning and execution.

Downtime Analysis

The following data presents the total machine downtime recorded for different reasons:

Downtime Cause	Total Hours (6 Months)	Percentage of Total Downtime (%)
Equipment Failure	210	40%
Changeover Time	120	23%
Operator Issues	90	17%
Maintenance Activities	80	15%
Other Factors	30	5%



Discussion: Equipment failure contributed to the highest downtime (40%), highlighting the need for preventive maintenance strategies. Reducing changeover time and improving operator efficiency could further enhance production output.

CONCLUSION

This study highlights the significance of Overall Equipment Effectiveness (OEE) in improving production performance at Tata Advanced Systems Limited. The findings indicate that OEE levels are below the optimal industry benchmark, leading to inefficiencies in achieving planned production targets. Key challenges identified include frequent equipment failures, performance losses, and high changeover times, all of which negatively impact production efficiency.

The analysis further reveals a consistent deviation between planned and actual production, indicating gaps in machine utilization and process execution. Machine downtime due to equipment failures emerged as

a critical issue, emphasizing the need for effective preventive maintenance strategies. Additionally, optimizing performance and minimizing process inefficiencies can significantly enhance production outcomes.

To bridge the production gap, Tata Advanced Systems Limited must focus on improving machine performance, reducing downtime, and implementing data-driven production planning strategies. Addressing these inefficiencies will contribute to enhanced operational efficiency, optimized resource utilization, and improved overall productivity.

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