

A Study on OEE Improvement through TPM at Nelcast Ltd

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ABSTRACT: The scope of the research work is to examine OEE improvement through TPM, Planned Preventive Maintenance Practices, and Focused Improvement (Kaizen) Activities on Equipment Performance Efficiency. The research work includes the identification of the most important variables in the maintenance field to determine their effect on improving production efficiency and minimizing losses during operation. Descriptive research design and convenience sampling method has been used. The research work is based on the data collected from a sample population of 120 respondents who are employees of the organization involved in production and maintenance operations. Questionnaire has been used as a primary data. Simple percentage analysis, chi-square analysis, correlation statistical tools have been applied to reach the findings of the study by using SPSS. It is observed that TPM at Nelcast Ltd. has an appreciable impact on OEE as it improves equipment reliability, reduces equipment downtime, and increases the level of operator engagement in maintenance tasks. This research study demonstrates that systematic approaches toward TPM like autonomous maintenance, preventive maintenance, and focused improvement significantly assist in reducing downtime and increasing equipment availability and performance. It is also inferred from the research study that the consistent application of TPM with active employee participation and maintenance practices results in tangible benefits for productivity and efficiency. It is evident from the research that continuous emphasis on fault detection, maintenance scheduling, and Kaizen significantly contributes to improving OEE at Nelcast Ltd.

KEYWORDS: Overall Equipment Effectiveness (OEE), Total Productive Maintenance (TPM), Equipment Efficiency, Preventive Maintenance.

I. INTRODUCTION

Overall Equipment Effectiveness (OEE) is a method of measuring the effectiveness of equipment usage in the production process. It helps in understanding the efficiency of equipment usage and supports organizations in improving productivity and equipment performance. OEE is a measure of equipment effectiveness in producing quality products without equipment failure, speed losses, or defects. It helps in understanding production losses and areas that need improvement. OEE gives a complete understanding of equipment efficiency and supports organizations in improving productivity and equipment performance. OEE is used in manufacturing industries as an important measure of equipment excellence.

It is important to have effective equipment management to avoid unexpected breakdowns of equipment in modern production systems. Unexpected breakdowns of equipment disrupt the flow of work, causing delays in the production timeline and rising production costs. Equipment management helps in detecting possible breakdowns before they happen. This ensures smooth flow of production and optimal use of available equipment. Downtime directly affects productivity and customer satisfaction. Hence, equipment management is required to ensure uninterrupted production. Modern production systems require high efficiency to be competitive in the market. Equipment management ensures that equipment runs at optimal speed and capacity. Equipment management ensures optimal equipment performance through proper calibration, inspection, and preventive maintenance. Efficient equipment use minimizes performance gaps and maximizes output. This helps in meeting production goals on schedule. Equipment management is critical in improving overall production efficiency. The condition of equipment has a direct impact on the quality of the end

product. Unmaintained equipment can result in defects, rework, or production of scrap material. Proper equipment management will ensure that equipment is run in controlled and standardized environments. Maintenance of equipment helps in minimizing variations in the production process. This helps in maintaining a consistent quality of the product and meeting customer requirements. Hence, equipment management plays an important role in maintaining quality standards in modern industries.

OBJECTIVES OF THE STUDY

- To analyze the extent of Autonomous Maintenance Implementation in the organization
- To examine the Planned Preventive Maintenance Practices in the organization
- To assess the Focused Improvement (Kaizen) Activities in the organization
- To determine the Equipment Performance Efficiency in the organization

II. REVIEW OF LITERATURE

Bashir (2023) researched preventive maintenance practices and its effect in efficiency within equipment of Malaysian manufacturing companies. The purpose of the study was to find out the impact that structured maintenance schedules have on production continuity and OEE measurements. One hundred and twenty respondents were involved and the information was gathered using surveys and organizational maintenance records. The study used a quantitative study that is descriptive in nature, convenience sampling, and regression. The results revealed that preventative maintenance, which was well anticipated, would lead to great availability of the manufactured equipment and minimization of unforeseen breakdowns.

Alkazemi (2024) the role of preventive maintenance practices in enhancing the reliability of production systems in Middle Eastern manufacturing companies. The aim of this study was to investigate the role of PPM in improving OEE and reducing costs. The sample population included 140 technical personnel who were selected using stratified sampling, and data was collected using questionnaires and maintenance performance. The study employed a quantitative approach using partial least squares structural equation modeling. The findings of the study showed that preventive maintenance had a positive impact on enhancing availability and minimizing losses associated with maintenance.

Rahman (2025) examined how the preventive maintenance implementation is related to OEE improvement in large-scale manufacturing organizations in South Asia. The aim of the study was to examine the effect of preventive maintenance planning on the production efficiency and downtime of equipment. The sample population of 160 maintenance engineers and operators was sampled systematically with the help of the maintenance and operator questionnaires which were structured and assisted by the production records. The method of quantitative research of the structural equation modeling was used. Results indicated that good preventive maintenance programs yielded much better availability and fewer corrective interventions. The author proposed ongoing control and assimilating preventive maintenance and TPM pillars. The paper came to a conclusion that PPM is a critical factor in maintaining general equipment performance.

III. RESEARCH METHODOLOGY

This study adopts a descriptive research design. Convenience sampling is adopted in this study. Both primary data and secondary data are applied to the study. The size of the sample to be used in this study is 120 respondents. Simple percentage analysis, chi square analysis and correlation have been used in this study.

Data analysis and interpretation

Table No. 1 AUTONOMOUS MAINTENANCE IMPLEMENTATION

Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Operators regularly perform routine cleaning of	46 (30.7%)	55 (36.7%)	24 (16%)	15 (10%)	10 (6.6%)	150 (100%)

equipment						
Basic inspection activities are carried out by machine operators	44 (29.3%)	57 (38%)	23 (15.3%)	16 (10.7%)	10 (6.7%)	150 (100%)
Standard procedures are followed for daily equipment checks	48 (32%)	52 (34.7%)	22 (14.7%)	18 (12%)	10 (6.6%)	150 (100%)
Early signs of equipment abnormalities are properly identified	42 (28%)	58 (38.7%)	24 (16%)	16 (10.7%)	10 (6.6%)	150 (100%)
Autonomous maintenance practices reduce minor equipment failures	50 (33.3%)	54 (36%)	20 (13.3%)	16 (10.7%)	10 (6.7%)	150 (100%)

Source: Primary data

Interpretation

Respondents reveal that 30.7% strongly agree and 36.7% agree that operators regularly perform routine cleaning of equipment, while 16% are neutral, 10% disagree, and 6.6% strongly disagree. Regarding basic inspection activities carried out by machine operators, 29.3% strongly agree and 38% agree, with 15.3% neutral, 10.7% disagree, and 6.7% strongly disagree. For following standard procedures for daily equipment checks, 32% strongly agree and 34.7% agree, while 14.7% are neutral, 12% disagree, and 6.6% strongly disagree. In terms of identifying early signs of equipment abnormalities, 28% strongly agree and 38.7% agree, with 16% neutral, 10.7% disagree, and 6.6% strongly disagree. Finally, 33.3% strongly agree and 36% agree that autonomous maintenance practices reduce minor equipment failures, while 13.3% are neutral, 10.7% disagree, and 6.7% strongly disagree.

Table No. 2 PLANNED PREVENTIVE MAINTENANCE PRACTICES

Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Preventive maintenance activities are carried out as per schedule	48 (32%)	52 (34.7%)	22 (14.7%)	18 (12%)	10 (6.6%)	150 (100%)
Spare parts are available for planned maintenance activities	44 (29.3%)	55 (36.7%)	23 (15.3%)	18 (12%)	10 (6.7%)	150 (100%)
Breakdown frequency has reduced due to preventive maintenance	46 (30.7%)	54 (36%)	24 (16%)	16 (10.7%)	10 (6.6%)	150 (100%)
Maintenance schedules are clearly defined and documented	50 (33.3%)	50 (33.3%)	25 (16.7%)	15 (10%)	10 (6.7%)	150 (100%)
Planned maintenance improves equipment reliability	52 (34.7%)	52 (34.7%)	20 (13.3%)	16 (10.7%)	10 (6.6%)	150 (100%)

Source: Primary data

Interpretation

Respondents reveal that 32% strongly agree and 34.7% agree that preventive maintenance activities are carried out as per schedule, while 14.7% are neutral, 12% disagree, and 6.6% strongly disagree. Regarding spare parts availability for planned maintenance, 29.3% strongly agree and 36.7% agree, with 15.3% neutral, 12% disagree, and 6.7% strongly disagree. For reduction in breakdown frequency due to preventive maintenance, 30.7% strongly agree and 36% agree,

while 16% are neutral, 10.7% disagree, and 6.6% strongly disagree. In terms of maintenance schedules being clearly defined and documented, 33.3% strongly agree and 33.3% agree, with 16.7% neutral, 10% disagree, and 6.7% strongly disagree. Finally, 34.7% strongly agree and 34.7% agree that planned maintenance improves equipment reliability, while 13.3% are neutral, 10.7% disagree, and 6.6% strongly disagree.

Table No. 3 EQUIPMENT PERFORMANCE EFFICIENCY

Statements	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Equipment operates at the expected production speed	50 (33.3%)	52 (34.7%)	20 (13.3%)	18 (12%)	10 (6.7%)	150 (100%)
Production targets are consistently achieved by machines	48 (32%)	54 (36%)	22 (14.7%)	16 (10.7%)	10 (6.6%)	150 (100%)
Equipment idle time is minimal during operations	46 (30.7%)	55 (36.7%)	23 (15.3%)	16 (10.7%)	10 (6.6%)	150 (100%)
Machines function smoothly without frequent interruptions	52 (34.7%)	50 (33.3%)	20 (13.3%)	18 (12%)	10 (6.7%)	150 (100%)
Output levels meet planned production capacity	54 (36%)	52 (34.7%)	18 (12%)	16 (10.7%)	10 (6.6%)	150 (100%)

Source: Primary data

Interpretation

Respondents reveal that 33.3% strongly agree and 34.7% agree that equipment operates at the expected production speed, while 13.3% are neutral, 12% disagree, and 6.7% strongly disagree. Regarding production targets being consistently achieved by machines, 32% strongly agree and 36% agree, with 14.7% neutral, 10.7% disagree, and 6.6% strongly disagree. For equipment idle time, 30.7% strongly agree and 36.7% agree that it is minimal during operations, while 15.3% are neutral, 10.7% disagree, and 6.6% strongly disagree. In terms of smooth machine functioning without interruptions, 34.7% strongly agree and 33.3% agree, with 13.3% neutral, 12% disagree, and 6.7% strongly disagree. Finally, 36% strongly agree and 34.7% agree that output levels meet planned production capacity, while 12% are neutral, 10.7% disagree, and 6.6% strongly disagree.

IV. CHI-SQUARE ANALYSIS: RELATIONSHIP BETWEEN AUTONOMOUS MAINTENANCE IMPLEMENTATION AND EQUIPMENT PERFORMANCE EFFICIENCY

HYPOTHESIS TESTING

Null hypothesis (H0): There is no significant relationship between autonomous maintenance implementation and equipment performance efficiency.

Alternative hypothesis (H1): There is some significant relationship between autonomous maintenance implementation and equipment performance efficiency.

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	190.189 ^a	210	.833
Likelihood Ratio	158.377	210	.997
Linear-by-Linear Association	1.947	1	.163
N of Valid Cases	120		

a. 240 cells (100.0%) have expected count less than 5. The minimum expected count is .01.

INTERPRETATION:

As per the above table, it is inferred that the P value is .833; it is not significant to 5% (0.05) significant level. The minimum expected count is .01. Thus null hypothesis is accepted and it is finding that there is no significant difference between autonomous maintenance implementation and equipment performance efficiency.

V. CORRELATION ANALYSIS: RELATIONSHIP BETWEEN PLANNED PREVENTIVE MAINTENANCE PRACTICES AND EQUIPMENT PERFORMANCE EFFICIENCY

HYPOTHESIS TESTING

Null hypothesis (H0): There is no significant relationship between planned preventive maintenance practices and equipment performance efficiency

Alternative hypothesis (H1): There is some significant relationship between planned preventive maintenance practices and equipment performance efficiency

Correlations			
		PLANNED PREVENTIVE MAINTENANCE PRACTICES	EQUIPMENT PERFORMANCE EFFICIENCY
PLANNED PREVENTIVE MAINTENANCE PRACTICES	Pearson Correlation	1	.318**
	Sig. (2-tailed)		0
	N	120	120
EQUIPMENT PERFORMANCE EFFICIENCY	Pearson Correlation	.318**	1
	Sig. (2-tailed)	0	
	N	120	120

** . Correlation is significant at the 0.01 level (2-tailed).

INTERPRETATION

The above table indicates that out of 120 respondents, co-efficient of correlation between planned preventive maintenance practices and equipment performance efficiency is .318. It is below 1. So there is positive relationship between planned preventive maintenance practices and equipment performance efficiency.

VI. SUGGESTIONS

- To prevent contamination build up, the company must ensure that the operators carry out routine cleaning to ensure that the basic equipment is not worn out or damaged.
- The firm needs to create a structured operator-based inspection schemes to facilitate early detection of abnormalities.
- The company should ensure that standardized checklists are used such that the checking of equipment on a daily basis and across shifts is conducted.
- To enhance detection of early warning signs of equipment problems, the company needs to enhance operator training.
- The company should reinforce independent maintenance operations to make sure that it reduces further even minor recurrence and interruption of its breakdowns.
- The company should also be sensitive in monitoring the preventive maintenance schedules in order to avoid unexpected equipment breakdowns.
- The firm needs to enhance planning of spare parts and inventory management to facilitate the maintenance performance of the firm.
- The company ought to persist in enhancing preventive maintenance to maintain and minimize further breakdowns.
- The company ought to have well-documented maintenance schedules so as to have a sense of accountability and transparency among teams.
- The firm should also make sure that the intended maintenance strategies are implemented at all times to enhance long term reliability and performance of equipment.

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- The company should encourage regular small groups conversations to resolve equipment issues in a team fashion and approach.
- To eliminate frequent equipment failures, the company must increase the root cause analysis.
- The company ought to put in place a systematic review mechanism to have the employee suggestions reviewed and where possible they are put into action.
- The company should enhance the engagement programs so that the employees can become more engaged in continuous improvement programs.
- Kaizen should be maintained in the company to ensure that the company keeps on enhancing operational efficiency and productivity results.
- The company should also increase the dependability of maintenance to minimize interruptions in operations that are frequent.
- The firm should optimize on the number of equipments used in production to ensure that the production will never exceed the planned production capacity.

VII.CONCLUSION

It is observed that TPM at Nelcast Ltd. has an appreciable impact on OEE as it improves equipment reliability, reduces equipment downtime, and increases the level of operator engagement in maintenance tasks. This research study demonstrates that systematic approaches toward TPM like autonomous maintenance, preventive maintenance, and focused improvement significantly assist in reducing downtime and increasing equipment availability and performance. It is also inferred from the research study that the consistent application of TPM with active employee participation and maintenance practices results in tangible benefits for productivity and efficiency. It is evident from the research that continuous emphasis on fault detection, maintenance scheduling, and Kaizen significantly contributes to improving OEE at Nelcast Ltd.

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