

Implementation of Total Productive Maintenance to Improve Overall Equipment Effectiveness in Cylinder Head Bay

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Abstract — Total Productive Maintenance implementation study in a commercial automobile company is discussed in this paper. This overview is carried out specifically in cylinder bay section by using the observations coupled with documents they practiced. Here, TPM implementation methodology is suggested to make impact and directly contribute for the reduction of downtime, improving Overall Equipment Effectiveness and personnel involvement. The work is explained in five stages in the order that, TPM implementation, questionnaire preparation, data collection, analysis and OEE calculation. The foresaid criterion has been developed to determine the objective of level of success about TPM implementation in the organization.

Keywords — TPM, OEE, Downtime, Flow shop.

I. INTRODUCTION

The concept of Total Productive Maintenance (TPM) has been introduced and developed by Japanese. It is team based preventive and productive maintenance activity which involves in every level, from top executive to the floor operator. TPM is a company-wide system developed to maintain, monitor, and improve all capital assets of a company. TPM philosophy requires the development of a preventive maintenance program for the life-cycle of the equipment and the involvement of operators in maintaining the equipment in order to maximize its overall efficiency and effectiveness. For production it is a system that maximizes equipment effectiveness and maintains product flow. TPM is not just about “maintenance”. It is about getting the most overall benefit from your equipment over the life of the equipment. TPM will not be an overnight success. Implementing it throughout a plant correctly will take several years. It does not take account of equipment costs and profits, and so it is not a good measure for comparing machines or systems, or for comparing the effect of equipment deterioration over time. TPM has been more often misunderstood than understood. It is mostly misinterpreted as synonymous with autonomous maintenance or operator involvement. If that were the case, TPM would not be “total productive maintenance” but rather operator-performed Maintenance (OPM). TPM will lead to world-class levels of

equipment performance and reliability at the lowest possible operating costs.

A. TPM Approach

In this section the overall structure of TPM is approached. As initial step introduction of TPM decisions is formally announced. Then TPM introductory education and publicity campaign can be conducted. Later, TPM promotion organization structure, establishment of basic TPM policy and goals can be created. At last, master plan can be drafted for implementation of TPM.

B. Methodology For TPM & OEE Development

A Flow chart as shown in figure 1 be prepared and from it the TPM development stages are identified to meet effective growth. From figure 1 the proposed methodology carried out is discussed as follows, in stage 1 the implementation is suggested as steps.

- Step 1. Announcement about TPM introduction in company by management.
- Step 2. Initial education and propaganda for TPM will be done.
- Step 3. Setting up TPM and developmental committees.
- Step 4. Establishing the TPM working system and target.

In stage 2 some set of questions can be prepared as questionnaire to conduct survey. In stage 3 the prepared questionnaire can be distributed to company people to collect their data's about TPM effectiveness. In stage 4 the collected data's will be analyzed through charts. In stage 5 OEE will be calculated and finally in stage 6 the results will be studied.

C. Implementation of TPM & OEE in Cylinder Head Bay

The actual implementation of TPM in automobile company Ashok Leyland, Unit-1 Shop V cylinder bay is discussed in this section. Through this paper the various difficulties faced in company are solved by using the suggestions provided by the author.

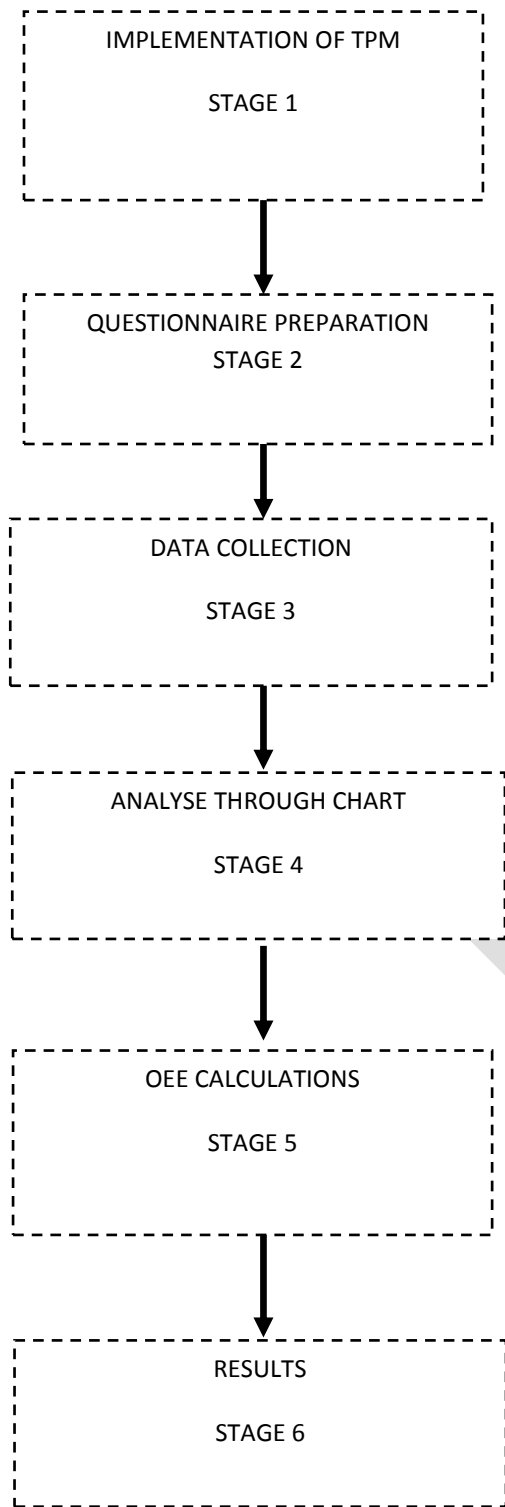


Fig. 1 - Methodology stages

Stage 1- Implementation of TPM

Through this stage the implementation of TPM will be done in the company. So as to achieve good results, particularly in reducing equipment break downs, minimizing idling and minor stoppages, minimizing quality defects &

claims. In addition to increase productivity, trimming labor cost, shrinking inventory, cutting accidents and promoting employee’s morale etc.

Stage 2- Questionnaire Preparation

In this stage some set of questions were developed on the basis of questionnaire. Here three set of questionnaire as theme of downtime reduction with 13 questions, theme of OEE with 6 questions and theme of personnel involvement with 9 questions were prepared. The questions used for development of questionnaire are given in appendix section. The same will be analyzed by Likert’s Scale.

Stage 3- Data Collection

In this data collection stage the three set of questionnaires were circulated to collect data from executives, operators during their shift time. The questionnaire survey has been collected from 20 executives and 50 operators who are all involved in cylinder bay section. The survey was conducted during four different period’s in order to get effective answer. Among the collected data 100 samples are analyzed through charts. Similarly the data for OEE are also collected from the log of daily production in four phases.

Stage 4- Analyze Through Chart

In analysis stage the 100 selected samples are used to prepare chart. The answer grades are as Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (DA). This analysis was made for theme of downtime reduction, theme of OEE and theme of personnel involvement from executives and operators. The summary of analysis is shown in charts in figure 2 to figure 7.

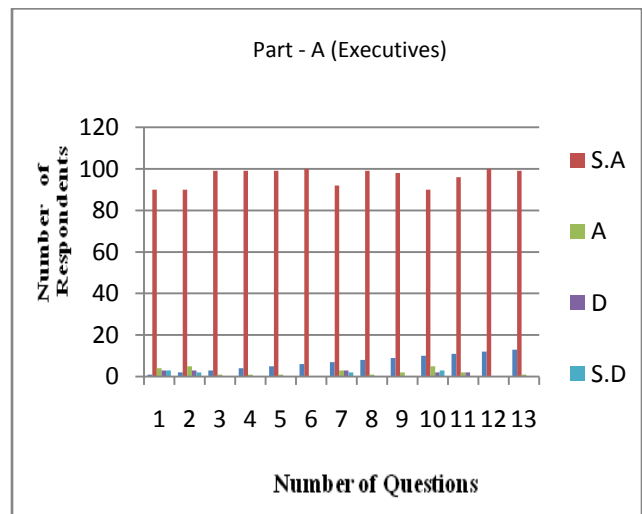


Fig 2. Theme of downtime reduction among executives

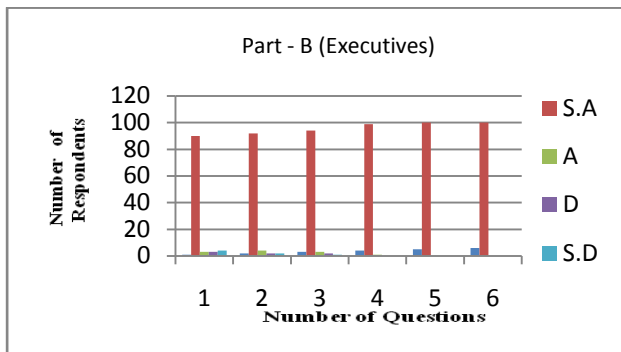


Fig 3. Theme of OEE among executives

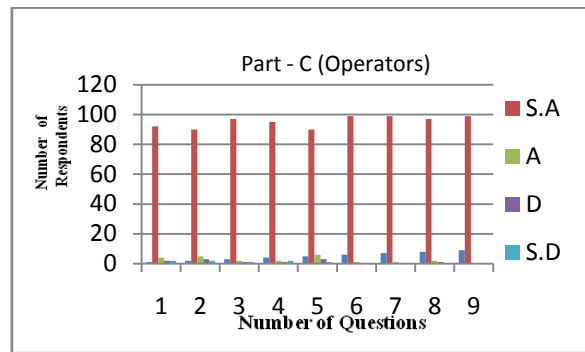


Fig 7. Theme of personnel involvement among operators

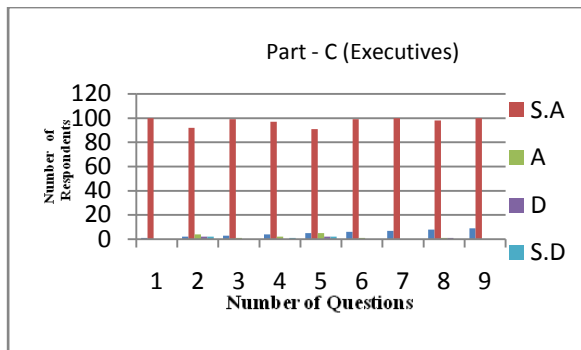


Fig 4. Theme of personnel involvement among executives

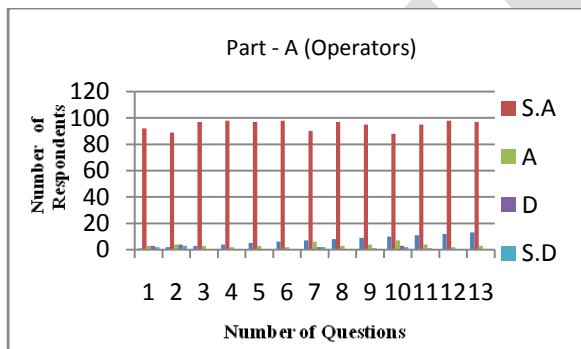


Fig 5. Theme of downtime reduction among operators

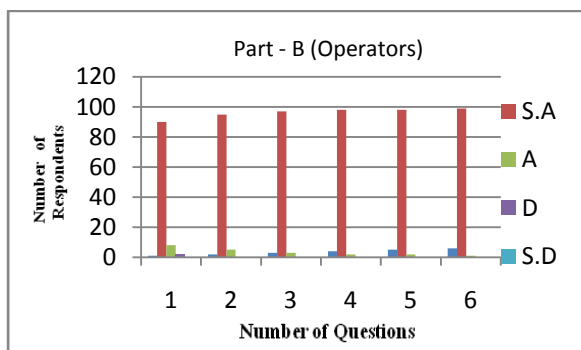


Fig 6. Theme of OEE among operators

Through the analysis it was observed that most of executives and operators suggested strongly agreed and agreed answer grade for implementing TPM and OEE working environment.

Stage 5- OEE Calculations

Overall Equipment Effectiveness breaks the performance of a manufacturing unit into three measurable impacts called Availability, Performance and Quality. The hierarchy structure of OEE is shown in figure 8. By adopting OEE we can prevent the losses due to Breakdown, setup and adjustment time, Speed reduction, Idle and minor stoppages, Rejection and Rework, Startup rejects.

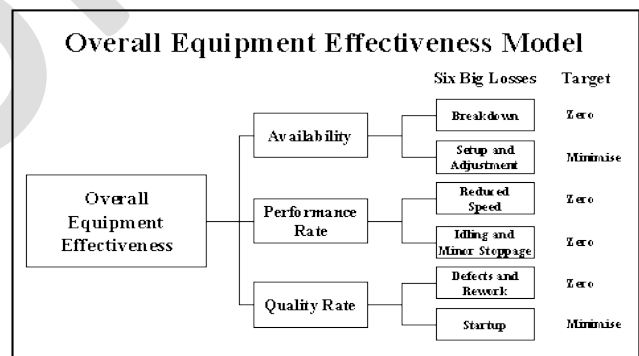


Fig 8. Overall Equipment Effectiveness

The three metric values can be calculated using the simple formula that,

1. AVAILABILITY = Run Time / Total Time
2. PERFORMANCE = Total Count / Target Counter
3. QUALITY = Good Count / Total Count

The data's were collected for four weeks from production line are used to calculate OEE and the calculated values are listed in the Table 1.

TABLE 1 – OEE Values of Cylinder head bay

STAGES	BEFORE IMPLEMENTATION		AFTER IMPLEMENTATION	
	Phase I values	Phase II values	Phase III values	Phase IV values
Shift Length	510	510	510	510
Run Time	332	342	349	357
Breaks	70	50	70	70
Setup Time	26	50	64	78
Down Time	30	20	13	05
Total Time	440	440	440	440
Ideal Cycle Time	1 part every 300 secs	1 part every 300 secs	1 part every 300 secs	1 part every 300 secs
Total Count	70	74	79	85
Good Count	63	67	73	83
Target Counter	85	85	85	85
Availability	75.45%	77.72%	79.31%	81.13%
Performance	82.35%	87.05%	92.94%	100%
Quality	90.00%	90.54%	92.40%	97.64%
Simple OEE	55.91%	61.25%	68.10%	79.21%

Stage 6-Results

Thus, TPM is an improvement strategy that could be used alone or in combination with other improvement strategies to increase the organization's performance through equipment optimization. It appears that weaknesses remain in the current TPM system which is restrictive to further downtime reduction. Although downtime has been reduced, there needs to be a greater focus on implementation in order to achieve world class performance levels. The results from the project indicate that the OEE has increased and that the equipment is available when needed with the reduction of downtime as a major contributor to the success. Under the theme of personnel involvement, more training is needed to make the operators understand the formation of teams with common objectives to the site objectives, and that all personnel need to be trained by the maintenance technician to perform a lock out. TPM has been successfully implemented at Ashok Leyland Shop V cylinder head bay with minor adjustments and further improvements in manufacturing performance can be achieved.

II CONCLUSION

Total productive maintenance successfully gives the improvement in the availability, performance efficiency and quality rate, results in improvement of the overall equipment effectiveness of the equipment. While implementing TPM we found some barriers for effective implementation of TPM, such as Lack of Management Exposure, difficulty in understanding TPM methodology

and philosophy by middle management. The aim of this paper is to spread awareness about TPM methodology and OEE in cylinder head bay sector. Thus, the objective and level of success about TPM implementation was achieved.

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APPENDIX

Theme of downtime reduction model Questionnaire

**IMPLEMENTATION OF TPM AND OEE ENVIRONMENT
QUESTIONNAIRE**
COMPANY NAME:- Ashok Leyland, Unit-1, Machine Shop V (Cylinder head bay)

Part – A Theme of Downtime Reduction:

1. Through TPM, the equipment is maintained in a clean basic condition by remedying the sources of contamination.

S.A A D S.D

2. The lubrication points/surfaces are identified and serviced as per the specified standard.

S.A A D S.D

3. Loose fasteners on equipment are immediately secured if observed.

S.A A D S.D

4. The equipment is used as per the manufacturer’s guideline.

S.A A D S.D

5. Through TPM, the maintenance department performs routine inspections on all the equipment on site.

S.A A D S.D

6. The maintenance department restores or replaces defective parts as required.

S.A A D S.D

7. The maintenance/engineering department corrects equipment design weaknesses.

S.A A D S.D

8. The maintenance department follows a standardized servicing procedure.

S.A A D S.D

9. The maintenance department maintains critical spares for all equipment.

S.A A D S.D

10. All line stoppages which last longer than five minutes are recorded and tracked on displays in the production area.

S.A A D S.D

11. The maintenance technician's workmanship is to standard.

S.A A D S.D

12. Through the implementation of TPM, the downtime has been reduced.

S.A A D S.D

13. TPM reduces maintenance costs.

S.A A D S.D

Theme of Overall Equipment Effectiveness model Questionnaire

**IMPLEMENTATION OF TPM AND OEE ENVIRONMENT
QUESTIONNAIRE**

COMPANY NAME:- Ashok Leyland, Unit-1, Machine Shop V (Cylinder head bay)

Part – B Theme of OEE:

1. All micro failures are recorded and tracked on displays in the production area.

S.A A D S.D

2. Each breakdown that lasts longer than five minutes is analysed, the root cause established and corrective action taken.

S.A A D S.D

3. Adjustments are made to the equipment when the quality of the product is no longer acceptable.

S.A A D S.D

4. The causes of defects and reworks are removed from the equipment at the first incident.

S.A A D S.D

5. The quantity of reworks are recorded and tracked on displays in the production area.

S.A A D S.D

6. Through TPM, machine speed losses are detected.

S.A A D S.D

Theme of Personal Involvement model Questionnaire

**IMPLEMENTATION OF TPM AND OEE ENVIRONMENT
QUESTIONNAIRE**

COMPANY NAME:- Ashok Leyland, Unit-1, Machine Shop V (Cylinder head bay)

Part – C Theme of Personal Involvement:

1. The TPM, principles are applied at Leyland shop V.

S.A A D S.D

2. The operators are grouped into teams with common objectives which are aligned to the site.

S.A A D S.D

3. The team operates autonomously to achieve the daily objectives.

S.A A D S.D

4. The team performs own problem solving in a structured manner.

S.A A D S.D

5. The operators have been trained by the maintenance technician to perform TPM activities.

S.A A D S.D

6. TPM improves the teamwork between the production, maintenance and engineering departments.

S.A A D S.D

7. TPM involves every single employee, from top management to operators on the shop floor.

S.A A D S.D

8. The operators have been trained by the maintenance technician to perform lock out procedures before performing autonomous maintenance activities.

S.A A D S.D

9. TPM aims to achieve zero accidents

S.A A D S.D