

Investigation of Total Productive Maintenance Practices at Automotive Axles Ltd



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In the study, the role key success factors involved in TPM implementation for attaining better organization performance at Automotive Axles Ltd are analyzed. To test the feasibility of the questionnaire normality test is applied. The test reveals that data are not normally distributed hence for the analysis non-parametric c test like mean, standard deviation, Mann - Whitney U test, Chi-square test, and Kruskal - Wallies Z-Test are used to test the constructed hypothesis. The test reveals key success factors in TPM implementation are showing the significant difference in the organization performance.

Keywords: Key Success Factor, Feasibility, Performance

1. Introduction

Total Productive Maintenance (TPM) is a maintenance program which involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to increase production while, at the same time, increasing employee morale and job satisfaction. Also, TPM helps in bringing maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity. Downtime for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process to hold emergency and unscheduled maintenance to a minimum. To attain efficiency and effectiveness in equipment maintenance is very complicated. As the organization feels implementation of TPM is not an easy task, which is considered as a burden because of behavioral patterns of workers. The organizations are facing a difficulty in changing peoples' mindsets from a traditional maintenance approach to modern approach like TPM implementation. Therefore, a study is being carried out to identify key success factors for the implementation of TPM in organizations.

Henceforth, a study on TPM implementation practices in Automotive Axles Ltd is carried out. The Automotive Axles Ltd has been established in 1981 and joint venture of Kalyani Group and Meritor Inc, USA. The manufacturing unit is located at Mysuru (Karnataka). The organization is currently the largest independent manufacturer of Rear Drive Axle Assemblies in India. The company has also expanded its footprints in North India with establishment of new manufacturing plants at Jamshedpur. Over the past 30 years, it has been successfully implemented TPM practices. The details of the products manufacturing are as follows: Heavy duty Drive axles, Front Steer axles, Non-Drive axles, Axles for Defense & Off-Highway applications and Drum & Disc Brakes. Recently it has forayed into manufacturing of Light duty Drive axles. Over the years Automotive Axles Ltd has maintained impressive domestic OEM clients that includes Ashok Leyland, Tata Motors, Asia Motor Works, Daimler India, Volvo India, SML Isuzu Ltd., Volvo Eicher Commercial Vehicles, Vehicle Factory-Jabalpur, BEML, MAN Trucks Pvt. Ltd., Mahindra Trucks & Buses, CAT, Escorts, TIL and Sonalika. The organization also exports axle parts to USA, France, Italy, China, Brazil and Australia etc.

2. Review of Literature

Many research works have been carried out on the topic in that only few literatures are mentioned below:

Jeon, Kim, and Lee, (2011) have analyzed the performance (efficiency) of the various activities of total productivity maintenance by employing three-stage data envelopment analysis. The study considered the overall process of TPM implementation and self-directed working team for measuring the performance. Correlation and cluster analysis were carried out to know the relationship of the efficiency scores. Results indicated that by employing DEA in each stage the efficiency can be further enhanced.

Poduval and Pramod, (2013) have focused on barriers in TPM Implementation in Industries. To highlight the difficulties faced by organizations in implementing Total Productive Maintenance (TPM). Also, to understand the factors that hinder the implementation of TPM. In the study briefly explained the concepts and why TPM is a must for organizations in this complex dynamic business environment.

Kumar & Kapil, (2013) have undertaken a study on maintenance from total productive maintenance to world class maintenance. The study has highlighted retrospective growth of need of maintenance of equipment in the organization. Henceforth a depth study on world class maintenance system in any industry are carried out with the implementation of TPM. To understand maintenance system with its components, modules and key success factors for attaining overall equipment efficiency in the production process.

Sharma and Singh, (2015) have portrayed a study on impact of implementing Japanese 5S practices on Total Productive Maintenance. The study identified the effectiveness of 5S practices on the TPM implemented organization performance. The

result of this study confirms that all 5S principles affect TPM directly or indirectly. Consequently, 5S is an effective tool which strongly supports the objectives of TPM implemented organization to achieve continuous improvement and higher performance.

Kedar, Borikar, Kedar, and Borikar, (2016) has conducted a study on critical success factors for effective implementation of TQM and TPM. The study reveals quality management cannot be achieved without the sustained performance of equipment affecting product quality, hence TPM has become important. TQM and TPM approaches are generated in developed countries. It is found that TQM and TPM have a similar background, some common factors, which have a positive impact on organizational performance. Hence a comparative study on the factors of TQM and TPM implementation is carried out. The results have revealed a positive impact on the organizational performance is possible only when the TPM and TQM are considered as a critical factor.

Raut and Raut, (2017) have focused on the implementation of TPM to enhance OEE in a medium scale industry. To understand the implementation of TPM and the need of OEE in the shop floor. The methodology adopted for improving the performances through 5S techniques, autonomous maintenance, kaizen, and planned maintenance. The results revealed after implementation of TPM the machine performances have increased eliminates breakdown and promotes autonomous operator maintenance. To enhance overall equipment effectiveness before and after TPM implementation validates the success of TPM implementation in the industry.

3. Research Methodology

1. **Research Design:** The research design adopted for the study is descriptive research design.
2. **Sources of Data:** The data are collected through primary and secondary sources.
3. **Primary Data:** The data are collected through structured questionnaires. The questionnaires are constructed using Likert Scale. The survey method adopted for collection of data is cross sectional survey design.
4. **Secondary Data:** Secondary data are gathered from different sources such as, Internet, website, Professional Magazines, refereed journals and peered journals related on TPM implementation in Manufacturing Industries.
5. **Focus Group:** Production Executives, Machine Operators and Maintenance Engineers of Automotive Axles Ltd, Mysuru.
6. **Sample Method:** Non-probability sampling method is adopted in the study.
7. **Sample Technique:** The quota sampling technique is adopted to carry out the study.
8. **Sample size:** Around 50 employees from the Automotive Axles Ltd are considered for the study.
9. **Tools for Analysis:** To check the feasibility of the data normality test are used to identify whether the data are normally distributed or not. The test adopted to check the normality is **Shapiro-Wilks W test (P=0.412)**. The test reveals that **A significant test means of sample distribution is not shaped like a normal curve (p < 0.05)** and the sample size is small N = 30. Henceforth, we applied **non parametric test like mean, standard deviation, Mann – Whitney U test, chi square test and Kruskal – Wallis Z-Test.**

3.1 Objectives

The following are the Major Objectives of the Study

1. To assess the goals for implementing TPM in Automotive Axles Ltd.
2. To analysis the assistance from external agencies for implementation of TPM in Automotive Axles Ltd.
3. To study the key success factors for implementation of TPM in Automotive Axles Ltd.

3.2 Hypotheses

The study is based on the following hypotheses

- **H1:** There is a significant relationship between the goals for implementing TPM.
- **H2:** There is a significant relationship between assistance from external agencies for implementation of TPM.
- **H3:** There is a significant relationship between key success factors for implementation of TPM.

4. Data Analysis And Interpretation

4.1 Demographic Profile of the Respondents

Table No.1 represents the demographic profile of employees of Automotive Axles Ltd, Mysuru city. The overall respondents are 50 employees out of that 40 employees belongs to male category and 10 respondents belongs to female category. This shows that male employees are actively participated in the survey than that of female employees. In the age pattern majority of the respondents numbering 18 belongs to age group of above 35 to 45. In educational background group majority of respondents numbering 25 are industrial engineering. In the occupation, majority numbering, 20 are belong to production executives. And numbering 22 are saying that good status of TPM implementation in the organization.

To analyse the data chi –square test is applied for gender, age pattern and occupation group. The test reveals that table value of χ^2 for degrees of freedom at 5% level of significance is significant. The calculated P value 0.001, 0.000, and 0.004 is less than the Alpha Value of 0.05. Therefore, the results indicate that the stated alternative hypothesis to be accepted. In the other part of analysis of data chi –square test for educational background and status of TPM implementation of respondent's table value of

χ^2 for degrees of freedom at 5% level of significance is not significant. The calculated P value 0.061 and 0.058 is more than the Alpha Value of 0.05. Therefore; the stated alternative hypothesis is to be rejected.

Table No. 1 Showing the Demographic Profile of the Employees of Automotive Axle Ltd
(Descriptive Statistics)

SI. No	Factors	Classification	Frequency	Chi-Square	Results
1.	Gender	Male	40	$\chi^2=2.01$	P=0.001 Significant
		Female	10		
2.	Age Pattern	Between 25-35 Years	15	$\chi^2= 3.12$	P=0.000 Significant
		Between 35-45 Years	18		
		Above 45 years	17		
3	Educational Background	Diploma in Engineering	10	$\chi^2= 1.17$	P=0.061 Non-Significant
		Industrial engineering	25		
		Mechanical engineering	15		
4	Occupation	Production Executives	20	$\chi^2= 3.11$	P=0.004 Significant
		Machine operators	12		
		Maintenance Engineers	18		
5.	Status of TPM in your Organization	Excellent	05	$\chi^2= 2.45$	P=0.058 Non-Significant
		Good	22		
		Fair	15		
		Poor	08		

Sources: Primary Data

Note: Level of Significance = 0.05

4.2 The Goals for Implementing TPM in the Organization

Table No.2 represents the goals for implementing TPM in the Automotive Axles Ltd. This study has mentioned some of the goals such as improve the quality and productivity, reduced the machine maintenance and production cost, increase organization competitiveness and reduce the machine breakdown and accident. Majority of the employees numbering, 20(40%) and 12(24%) are opinioned has improve the quality and productivity of the products and reduced the machine maintenance and production cost are main goals for TPM implementation in the Automotive Axles Ltd.

Table No.2 Goals for Implementing TPM

SINo	Statements	Frequency	Percentage
1.	Improve the quality and productivity	12	24.00
2.	Reduced the machine maintenance and production cost	20	40.00
3.	Increase organization competitiveness	07	14.00
4.	Reduce the machine breakdown and accident	11	22.00
	Total	50	100.00
Kruskal –Wallis Z-Test=2.752 Asymp. Sig.(2-tailed) =0.002 Mean Rank=15.17 Degree of Freedom=03			

Sources: Primary data

Note: Level of Significance = 0.05

Table No. 2, the Kruskal–Wallis Z-Test is a category of non-parametric test. The test describes the significant difference between the goals for implementing TPM in the organization. The P value (Sig 2-tailed) is 0.002, **which is less than the Alpha value of 0.05, hence the stated alternative hypothesis is to be accepted.**

4.3 Assistance from External Agencies for Implementation of TPM

Table No.3 represents the assistance from external agencies for implementation of TPM. Majority of the employees numbering, 30 (60%) and 20 (40%) are opinioned that private consultancy and CII Institute are the two major external

agencies are playing a vital role in implementation of TPM. Whereas to measure the efficacy of above two external agencies performance is good and the majority of the respondents numbering, 25(50%) and 12(24%) of the respondents are strongly agreed that effective and very effective performance have been shown in TPM implementation in Automotive Axel Ltd, Mysuru.

Table No.3 Assistance from External Agencies to Implementation of TPM

Sl.NO	Assistance from external agencies	Frequency	Percentage
1.	Private Consultancy	30	60.00
2.	CII Institute	20	40.00
3.	Other (Please specify)	00	00.00
	Total	50	100.00
	Kruskal –Wallis Z-Test	Kruskal –Wallis Z-Test=3.011 Asymp. Sig.(2-tailed) =0.071 Mean Rank=18.17 Degree of Freedom=02	
II	Efficacy of external agencies assistance	Frequency	Percentage
1.	Very effective	12	24.00
2.	Effective	25	50.00
3.	Neither effective nor ineffective	00	00.00
4.	Ineffective	10	20.00
5.	Very Ineffective	03	06.00
	Total	50	100.00
	Kruskal –Wallis Z-Test	Kruskal –Wallis Z-Test=2.416 Asymp. Sig.(2-tailed) =0.000 Mean Rank=12.73 Degree of Freedom=04	

Sources: Primary Data

Note: Significant Level 0.05

Table No. 3, The Kruskal–Wallis Z-Test is a category of non-parametric test. The test describes significant difference between the assistance from external agencies to implementation of TPM. The P value (Sig 2-tailed) is 0.071, **which is more than the Alpha value of 0.05 hence the stated alternative hypothesis is rejected.** Whereas to test the significant difference between the efficacy of external agencies to implementation of TPM the P value (Sig 2-tailed) is 0.000, **which is less than the Alpha value of 0.05 therefore the stated alternative hypothesis is accepted.**

4.4 Key Success Factors for Implementation of TPM

Table No.4 highlights key success factors for implementation of TPM in Automotive Axel Ltd, Mysuru. Majority of the employees have strongly agreed and provided positive opinions about the all the key success factors for implementation of TPM. Hence to test the data MannWhitney U-test a category of non-parametric test is applied. The test describes the significant difference between key success factors for implementation of TPM. The highest mean and standard deviation are found to be ‘complete information about equipment performance’ and ‘problem solving tools and techniques’ and the value are 28.43 and 7.26 respectively. Whereas lowest mean and standard deviation are found in ‘Age and performance of equipment’ and ‘full-time worker (s) assigned to TPM tasks’ are recorded the value of 14.43 and 2.58 respectively.

Table NO.4 Key Success Factors for Implementation of TPM

SI. NO	Statements	Mean	S. D	Whitney U-Test	(Sig 2-tailed) P-value	Hypothesis
1.	Time availability to attend to TPM activities.	23.60	4.81	3.121	0.000	Significant
2.	Full time worker(s) assigned to TPM tasks.	25.92	2.58	2.034	0.053	Not Significant
3.	Adopt and follow effective maintenance Technicians.	24.83	6.40	2.113	0.001	Significant
4.	Right culture in the organization	13.87	5.21	2.141	0.000	Significant
5.	Effective cooperators ownership	16.31	3.01	3.174	0.002	Significant
6.	Age and performance of equipment	14.43	5.78	3.246	0.005	Significant
7.	Effective communication before and during the TPM implementation process.	19.48	4.37	2.851	0.063	Not Significant

8.	Union staff (shop-floor) support	20.22	5.08	2.001	0.091	Not Significant
9.	Top Management commitment	16.57	3.86	1.763	0.062	Not Significant
10.	Training of production staff on basic maintenance activities.	26.78	6.49	1.713	0.003	Significant
11.	Problem solving tools and techniques	27.87	7.26	2.652	0.000	Significant
12.	Good communication skills of the TPM coordinator	20.31	3.01	3.224	0.001	Significant
13.	Complete information about equipment performance	28.43	5.78	3.276	0.072	Not Significant
14.	Suppliers Quality Management	23.48	3.32	2.811	0.081	Not Significant
15.	Proper Strategic planning	20.11	5.08	2.421	0.051	Not Significant

Sources: Primary Data

Note: Significant Level 0.05

To be summarized that, from above analysis majority of the employees are positively opinioned about 'time availability to attend to TPM activities', 'adopt and follow effective maintenance technicians', 'right culture in the organization', 'effective cooperator ownership', 'age and performance of equipment', 'training of production staff on basic maintenance activities', 'problem solving tools and techniques', and 'good communication skills of the TPM coordinator'. Further, P value (Sig 2-tailed) which is indicating less than the Alpha value of 0.05 are found to be significant. Therefore, the results indicate that the stated alternative hypothesis is to be accepted. In the context of 'full-time worker(s) assigned to TPM tasks', 'effective communication before and during the TPM implementation process', 'union staff (shop-floor) support', 'top management commitment', 'complete information about equipment performance', 'suppliers quality management', and 'proper strategic planning' categories of P value (Sig 2-tailed) indicates more than the Alpha value of 0.05 and found to be not significant. Therefore, the results indicate that the stated alternative hypothesis is rejected.

5. Finding

In the study one common thing is observed that is the effect key factors on TPM implementation. As well as directly or indirectly the effect of TPM implementation has increased the organization overall performance and overall equipment efficiency at shop floor. Further, provided the chance to create a place in market for attaining long run profits with healthy competition in the area of production. In the study when we observe gender group one thing can be observed is that male respondents have actively participated than that of female respondents in the organization. In the context of age pattern, majority of the respondents numbering, 18 and 17 employees are belonging to age group of above 35 to 45 years and above 45 years respectively. Whereas in occupation group majority numbering, 20 and 18 respondents were belong to production executives and maintenance engineers respectively. Further in the study Majority of the employees 40% have strongly agreed opinioned that TPM helps to improve the quality and productivity of the products. In Kruskal Wallis test we found that highest mean are found to be complete information about equipment performance are obtained a value of 28.43. The highest standard deviation are found be problem solving tools and techniques impacting more on organization performance improvement and the score obtained is 7.26. In the key success factor analysis, the test has revealed the lowest mean and standard deviation are 'age and performance of equipment' (14.43) and 'full time worker(s) assigned to TPM tasks' (2.58) respectively.

6. Suggestions

1. It is suggested that the top management to allocate adequate resources for the implementation of TPM and maintenance of quality initiatives and should exhibit their commitment towards quality in all their actions.
2. Empower the employees through decentralization of decision making and encourage employees to be involved in decision making. When employees present appropriate strategy suggestions to adopt proper TPM implementation process.
3. The automobile industries should support and facilitate effective TPM implementation it will helps to multi-faceted benefits to the organization as well as employees.
4. ISO 9000 certified organizations are expected to follow Plan-Do- Check-Act (PDCA) principles for enabling continuous improvement. Hence it is suggested to adopt PDCA philosophy for the better practice of TPM.
5. The TPM practicing organizations are expected to have a collaborative culture in which there will be a shared vision, high degree of openness, high degree of empowerment. It is recommended to have a collaborative culture in the organizations to practice TPM.
6. The industry has to provide continuous training for the employees in the area of TPM. Both on-the-job and off-the-job training. Which helps the employees to actively take part in strategic decision making in the organization.

7. Conclusion

The present study highlights the key successful factors of total productive maintenance (TPM) implementation in Automotive Axles Ltd, Mysuru. From the above analysis Majority of the respondents has strongly agreed and positively opined about effective implementation of TPM in the organization. The study has highlighted in the analysis there is a significant difference between ‘time availability to attend to TPM activities’, ‘adopt and follow effective maintenance technicians’, ‘right culture in the organization’, ‘training of production staff on basic maintenance activities’, and ‘problem solving tools’ are the key successful factors adopted in TPM process to improve the organization overall performance. Further the external agencies such as private consultancy and CII institutions helps in effective function of TPM process and implementation at Automotive Axels Ltd.

8. References

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