

THE IMPACT OF TOTAL PRODUCTIVE MAINTENANCE PRACTICES ON OPERATIONAL PERFORMANCE: A Case Study in Footwear Industry of Bangladesh

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Abstract: Total Productive Maintenance (TPM) is a system that boosts the efficiency of machine & tools used in the production process. TPM is not just a preventive support program rather a holistic system following well thought out and orchestrated maintenance schedule. The study aims at finding relationship between TPM practices and operational performance of Bangladesh Footwear industry and suggests for a positive relationship. By actualizing TPM, organizations promote a Condition Based Maintenance (CBM) adequately. The operation flow is optimized by reducing several non-value-added activities and time such as bottlenecking, machine breakdown, queue time, waiting time, material handling time, etc. Eventually, this study will be useful in understanding the current situation of footwear industries about the degree of adopting TPM practices and evaluate TPM's effect on operational performance.

Keywords: OEE; TPM; Lead time; CBM; Technology assessment; queue time.

INTRODUCTION

The primary material of footwear, finished leather usually provided by the neighborhood tanneries in Bangladesh. Tanneries in Hazaribagh, a place located in old Dhaka started operations in 1960 later on turned into a 'money dairy animals' to win outside monetary forms. The Bangladesh Government has identified the leather industry as the life line industry after Readymade Garments Industry which is the world's highest exporting industry after China. Leather industry accounts for 3.5% of Bangladesh's annual exports of \$1.2 billion. The government also is providing number of incentives to the industry including tax incentives, duty free import of raw materials for 100% export oriented factories. Bangladesh has all possibilities to emerge as investment hub for global leather industry value chain. Many global giant brands are presently sourcing leather made products from Bangladesh.

TPM is a system and also a strategy which was first introduced by Japanese in 1952. This is an augmentation to Total Quality Management (TQM). It is characterized and composed program which wipe out the misfortunes brought about by separate of machines and supplies by distinguishing and assaulting all reasons for hardware break downs and framework down time. It is conceivable to keep up the plant, machinery and devices in beneficial state in least expense through TPM. It also leaves up machines that generates profits for the company. The core of TPM is quality data that ensures products quality. TPM was traditionally considered as cost center, however, it has now been proved as revenue generating center.

Cost caused to keep up hardware is considered as a quality expense. It is conceivable to acquire expressed quality through efforts by everybody by actualizing TPM system. In any case, Japanese has demonstrated that generation and support has high status. Efficiency envelops cost, quality, amount, endeavors, time, overhaul, scrap, working condition and intensity of the association. Traditionally maintenance used to be considered as and when required basis in most companies around the world but there is a paradigm shift after TPM was introduced. TPM contributes in achieving efficiency of the company. Implementation of value framework is utilized to get aggressive edge. All out beneficial upkeep (TPM) is one of the vital mainstays of value frameworks. TPM is considered by numerous authors to be a vital commitment to lean creation supporting in the Just in Time (JIT) assembling and TQM. This strategy of TPM builds association in fiscal and nonmonetary terms. This exercise leads to efficiency and aggressiveness of individual to gatherings, machine to plant and by and large total association. Associations having these two attributes can continue development without having apprehension of survival.

RESEARCH OBJECTIVES

General Objective

To study the impact of TPM on operational performance in footwear industries of Bangladesh.

Specific Objectives

- To examine the extent of TPM practices have been adopted in Footwear industries in Bangladesh.
- To find out the impact of TPM practices on Footwear industries of Bangladesh.

PROBLEM STATEMENT

Globally companies started using TPM for maintaining competitive advantage. Companies across the world are benefitting themselves implementing TPM though initially seems costlier. Researchers consistently found a positive correlation between TPM practices and operational performance in different industries. But Bangladesh manufacturing industries significantly lack in implementation of TPM, let alone Footwear industry. It is very important for Bangladesh Footwear industries to become both efficient and competitive in order to contribute more in the Bangladesh economy. This study aims in answering the question whether companies using TPM practices have higher productivity than companies not using it.

LITERATURE REVIEW

In the ever competitive business world, managers are taking much interest in implementing TPM in order to remain competitive through promoting operational performance. It gives companies competitive advantage over incumbents. This increased global competition is forcing companies to improve and optimize their productivity in order to remain competitive (Huang et al. 2003). The reliability and dependability of equipment of all kinds are decreasing with time (Vashisth and Kumar, 2011). This concern and reality has brought the maintenance functions into focus to improve the production system's performance across the industry. Manufacturing Engineering Society of Australia (1995) defined maintenance as the engineering decisions and linked actions, necessary and sufficient for optimization of specified equipment's capability. Maintenance can broadly be divided into two major categories; preventive maintenance and corrective maintenance (Waeyenbergh & Pintelon, 2002).

There are two main TPM approaches available in the literature i.e. Western and the Japanese Approach, but both have similarity. The Japanese approach is promoted by Japanese Institute of Plant Maintenance and described by Nakajima (Nakajima, 1984, Nakajima, 1989, Tajiri and Gotoh, 1992) and whereas, Western approach described by Willmott (Willmott, 1994). Points to be noted that the Western approach is closely tied to the Japanese approach. Preventive maintenance is carried out before machine breaks down and the objective of this is to promote continuous system production and avoid unplanned maintenance operation. Preventive maintenance can be thought of as use-based maintenance where maintenance activities are undertaken periodically in planned manner. TPM is an aggressive maintenance approach that aims to improve equipment performance avoiding equipment failures.

Brah & Chong (2007) found a positive correlation between TPM and business performance shown by all the six general constructs of corporate planning, top management leadership, human resource focus, process focus, total quality management focus and information system focus. No much studies trying to examine the impact of TPM on operational performance in Footwear industry of Bangladesh are available, though few studies are available in the global context. Available literatures have been reviewed in order to get an insight on the issue and to find out the gap that is prevailing in this area. Chowdhury & Alam, (2018) found a positive relationship between TPM practices and organizational performance in RMG industry of Bangladesh. No universal definition for operational performance is available in the literatures; many researchers have defined it depending on the particular industry in question. Voss et al., (2012) explains that operational performance refers to different aspects of an organization's process which can be quantified and easily measured.

TPM helps in increasing tools viability through enhancement of hardware accessibility, performance, efficiency and item quality (Rajendra et al, 2014). Krimit(2017) in his study found a positive relationship between TPM practices and operational performance in manufacturing companies. On the other hand Mckone, Schroeder & Cua (2001) states that TPM has a positive and significant relationship with low cost, high levels of quality, and strong delivery performance. There was a study conducted in Bangladesh RMG industry and found a positive relationship between TPM and different operational performance metrics including: efficiency improvement, technique ponder, work estimation and line adjusting (Sobur & Fatema 2005). Sayid (2017) argued that TPM improved process cycle efficiency in a shoe company of Bangladesh.

METHODOLOGY

There are 86 licensed footwear industry operating their business in Bangladesh. So, this 86 companies are the target population. As population size is known following formula by Krejci and Morgan (1970) has been for determining sample size:

$$S = \frac{X^2 NP (1-P)}{d^2 (N-1) + X^2 P (1-P)}$$

So, from this formula the desired sample size at a 95% confidence level and P=0.5 is:

$$S = \frac{X^2 NP (1-P)}{d^2 (N-1) + X^2 P (1-P)} = 70$$

The sample size of the number of factories is 70 where approximately 100 officials or executives related with production processes have been selected as respondents.

Table 1
Sample Distribution

Serial	Footwear industry based on area	weights	number of companies	respondents	remarks
1.	Gazipur	70 x 0.25	18	25	Factories and respondents selected with equal weights
2.	Savar	70 x 0.25	18	25	
3.	Dhaka	70 x 0.25	17	25	
4.	Chittagong	70 x 0.25	17	25	
Total			70	100	

HYPOTHESIS

H_0 : There is no difference of operational performance between footwear industries practicing TPM and who do not.

H_A : There is difference of operational performance between footwear industries practicing TPM and who do not.

CONCEPTUAL FRAMEWORK

The conceptual framework has been adopted from prior literatures though the studies have been conducted in other manufacturing companies. But this study

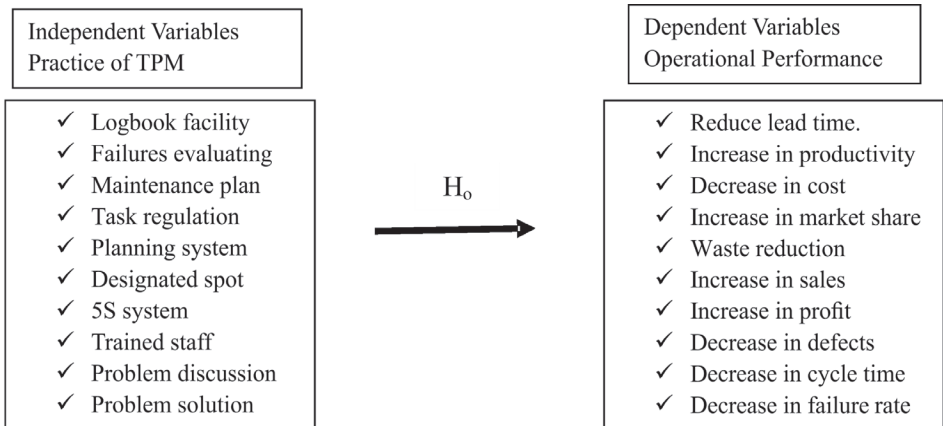


Figure: Conceptual Framework

is unique in its nature as no such study has been conducted in the Footwear industry of Bangladesh. Ten independent practices of TPM have been selected as independent variable whereas ten other metrics operational performance of Bangladesh Footwear industry have been considered.

RESULT AND DISCUSSION

A mixed method comprising both qualitative and quantitative method have been employed in conducting this study. Data were collected from the respondents through administering a questionnaire survey with both open and close ended questions in it. Measurement scale and constructs for measuring different variables have been adopted from prior literatures. Ten each constructs for measuring TPM practices and operational performance for the footwear industry have been considered in this study. Use of descriptive statistics and ANOVA test have been used for the testing the hypothesis so developed for statistical significance.

Descriptive Analysis (Overall TPM Performance)

<i>Items</i>	<i>N</i>	<i>Minimum</i>	<i>maximum</i>	<i>mean</i>	<i>Std. Deviation</i>	<i>Variance</i>
There is logbook for every production facility	100	1	4	3.36	.716	.512
Documented failures regularly evaluated and measures are taken	100	1	4	3.40	.722	.522
There are cleaning and maintenance plans	100	2	4	3.15	.828	.686
The responsibilities for the maintenance works are clearly regulated	100	1	4	2.71	.903	.815
Maintenance and repair planning and control systems are used to detect disorders	100	2	4	3.59	.589	.347
Every tool for maintenance and repair works have its designated spot	100	1	4	3.17	.839	.703
5s priority actions are carried out regularly to ensure cleanliness and order	100	1	4	2.98	.993	.987

<i>Items</i>	<i>N</i>	<i>Minimum</i>	<i>maximum</i>	<i>mean</i>	<i>Std. Deviation</i>	<i>Variance</i>
The employees from maintenance and repairs are included in the planning of production facilities	100	2	4	3.78	.527	.278
New employees are trained on the currently existing maintenance program	100	2	4	3.38	.582	.339
problems are discussed in the team and solution is looked for the problems	100	2	4	2.58	.724	.551
Valid N (List wise)	100	-	-	-	-	-

From the defined measurement scale, it has been decided that if mean value is equal or greater than 3; it means performance on that particular construct is low and if the same is smaller than 3; performance on that particular construct is high. So, from the table above, we can see that the highest mean value is 3.78 & lowest mean value is 2.58. The grand average mean from this table we get is 3.21. So, from this we can figure out that that the practices of TPM in Bangladesh in footwear industries is very low and limited.

Descriptive Analysis (Overall Operational Performance)

	<i>N</i>	<i>Minimum</i>	<i>maximum</i>	<i>mean</i>	<i>Std Deviation</i>	<i>Variance</i>
Increase in productivity	100	1	4	3.02	.763	.582
Decrease in Manufacturing cost	100	2	4	2.83	.632	.399
increase in market share	100	2	4	3.13	.460	.212
increase in annual sales revenue	100	2	4	3.36	.661	.437
increase in profit	100	2	4	3.50	.636	.405
Decrease in delivery lead time	100	2	4	3.48	.636	.404
decrease in defect or rejection rate	100	2	4	3.32	.725	.526
decrease in waste/scrap and rework	100	2	4	3.38	.753	.566
Decrease manufacturing cycle time	100	2	4	3.40	.739	.547
Decrease in equipment failure rate	100	2	4	3.45	.745	.554
Valid N (list wise)	100	-	-	-	-	-

Here, if mean is equal or greater than 3, then performance is low, and if mean is smaller than, 3 then performance is high. So, from the above table, it is evident that the highest mean value is 3.50 whereas, lowest is 2.83. The grand average mean from this table we get is 3.30. So, it can reasonably be inferred that overall operational performance in footwear industries is not at satisfactory level. This poor level of operational performance in Bangladesh Footwear industry is one of many reasons for which the industry is less competitive with global incumbents.

Apart from these descriptive statistics analysis, a independent sample t test has also been carried out for necessary interpretations. The analysis has been be given below for ease of understanding:

Table
Independent Sample t Test
Group Statistics

	<i>TPM User</i>	<i>N</i>	<i>Mean</i>	<i>Std. Deviation</i>	<i>Std. Error Mean</i>
Mean PQ	Company use TPM	11	2.8455	.61378	.18506
	Company Don't Use TPM	68	3.3735	.34538	.04188

Independent Samples Test

		<i>Leven's Test for Equality of Variances</i>		<i>t-test for equality of Means</i>						
		<i>F</i>	<i>Sig</i>	<i>t</i>	<i>df</i>	<i>Sig (2-tailed)</i>	<i>Mean Difference</i>	<i>Std. Error</i>	<i>Lower</i>	<i>Upper</i>
Mean PQ	Equal Variances Assumed	11.405	.001	-4.158	77	.0001	-.52807	.12700	-.78097	-.27518
	Equal Variances Not Assumed			-2.783	11.046	.018	-.52807	.18974	-.94548	-.11067

Here, if mean is equal or greater than 3 then operational performance is low or poor, and if mean is smaller than 3 then operational performance is high or good. So, here the companies those practice TPM have improved or positive operational performance compared to companies who do not practice TPM at all. Also, from independent sample test table, it is observed that significance level is smaller than 0.05; meaning null hypothesis has been rejected implying

that there is a difference of operational performance between footwear industries between companies following TPM and those not following TPM.

CONCLUSIONS

Bangladesh manufacturing industries in general lacks practicing of different contemporary management philosophies, let alone footwear industry. Practices like supply chain management, lean practices, TQM, JIT, TPM are not that practices here. Global companies are recouping benefits of these practices through remaining competitive and winning more orders. This study in this issue is unique in nature and is expected to contribute different policy makers and regulatory bodies for implementing TPM for promoting operational performance. Thus study showed that companies practicing TPM have higher operational performance than companies do not. It improves operational efficiency of different desired metrics and contribute companies being competitive in the country and beyond. But, employees at all levels are not that aware of importance implementing TPM in their manufacturing facilities. The industry is still heavily dependent on the traditional maintenance process. Many entrepreneurs consider cost incurred for planned and proactive maintenance as unproductive investment. They have a tendency of saving cost from the maintenance budget at the cost of machines going untimely out of order.

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