Measuring the effectiveness of total productive maintenance in the South African food manufacturing industry

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Abstract

The current economic growth has pushed the manufacturing sector to go through important changes over the past decade. The main reason of this situation is due to the current course of competition, which has been dramatically increasing in the local as well as global market. Consequently, the focus of both products' manufacturers and customers has been on the quality, delivery time, as well as product' cost. Due to these, many manufacturing industries seek to develop and implement a quality system to constantly enhance and increase both quality and throughput. Total Productive Maintenance (TPM) is considered as an approach aiming to guarantee an effective management of company's resources by means of employee participation and empowerment, as well as to augment the availability, quality, and product throughput to reduce the need for additional capital investment. To this end, the present paper proposes TPM as a roadmap for South African food manufacturing industry. Mixed methodology was used to obtain out of this study best possible results. The study was conducted at a larger South African food manufacturing company that has two sister companies (subsidiary A and B). both primary and secondary data were collected. The productivity and values of overall equipment effectiveness of both subsidiary A and B were calculated by employing standard equations. The findings revealed potential major challenges faced by those two sister companies. It was also shown in this study that both sister companies have less rate of overall equipment effectiveness when comparing to the world standard values, which caused many failures. Furthermore, there is a variation in terms of values of overall equipment effectiveness, performance, availability, and quality at both sister companies. Despite this fluctuation of value, we noticed that subsidiary A has got better performance than subsidiary B regarding productivity and overall equipment performance.

Keywords

Total Productive Maintenance, challenges, productivity, overall equipment effectiveness, South African manufacturing company.

I. Introduction

Within the current highly competitive worldwide market, quality is viewed as the key player to succeed in such harsh competitive environment. This ever-increase of global competition has fostered manufacturing companies across the world to turn their attention to Total Productive Maintenance (TPM). Whether in the United States, Europe, Asian, there is an increasing recognition of the necessity for continuous enhancement as a way of becoming and remaining competitive, mainly within the South African manufacturing sector whose market share has lately been losing ground to the developing economies of Asian, American and Western countries. A recent example, is the exist of General Motors from South African market, and this has proven the need for South African manufacturing industries to fully turn to TPM to be one step in advance of the competition by increasing management effectiveness and the providing of worth to the customer. In the concept of TPM, quality is not only considered in terms of manufactured goods or service, however, also as an essential factor for the cost-effective management of the material and human assets employed to deliver the manufactured goods or service. Intrinsically, it is a best option to customary methods to managing to guarantee the effectiveness of the business. Whilst, concurrently providing quality and adding value to buyers whose buying decisions generally depends mainly on this basis. Despite, most eagerly experienced within the economically emerging countries of US and Europe, this trend concerning more uncompromising end-users' expectations about quality is applied around the globe, particularly within countries where the buying power of consumers and the freedom of choice presented by a free market is extreme. Furthermore, in the previous decades the adoption and implementation of TPM was only considered as relevant to emerging economies as it is to the more innovative industrial countries.

I.1.Background

Over the past two decades, the South African manufacturing sector has been experiencing a significant revolution, including thorough shifts in management strategies, goods and process technologies, consumers expectations, supplier outlook as well as competitive behaviour. The current dynamic environment is becoming extremely demanding and complex for the industrial sector to manage competition and meet end-users' expectations. The worldwide market is witnessing a growing pressure from consumers and competitors for important worth from their purchase whether based on quality, quick delivery, and lower cost in manufacturing as well as service sector (Bash, 2001). Current competitive trend has impelled senior managers of various manufacturing companies to fully turn their attention at the performance of every business function, involving manufacturing or maintenance for attaining competitive advantage [7]. With the growing international competition, attention has altered from boosting effectiveness by means of economics of measure and internal specialization to respond to the market voice in terms of flexibility, delivery performance and quality [4]. Within nowadays' harsh environment a consistent manufacture framework should be viewed a crucial element for competitiveness (Chong, 2004). Deprived organizational skills in handling the upkeep function efficiently may harshly influence company business effectiveness, increasing inventory and leading to poor due-date performance [1]. There is a paucity of research concerning TPM in the South African manufacturing sector emphasises on the need for such a study. Thus, such study aims at raising the profile of TPM in South Africa case study will raise the profile of TPM in South Africa by determining challenges faced to implement TPM, establishing the success factors to implement TPM, and establishing the benefits related to TPM implementation in large South African food manufacturing company.

II. Total Productive Maintenance (TPM)

TPM is known as a Japanese novel approach aims at upholding plant and equipment. It may be viewed as a science of machinery and plant health. Greater manufacturing performance can deliver competitive benefit to the corporation. TPM is a well-organized and designed production method that deal with various tools and techniques to reach higher effective plants and equipment [2]. As mentioned earlier, within a harsh competitive current global environment, TPM has clearly demonstrated to be an efficient maintenance enhancement philosophy for impeding an organization from failing. Manufacturing system is becoming more and more intricate due to the introduction of new technologies and are extremely expensive to operate and manage [4]. Often, the industrial system operates at less than that of full capacity, causing insignificant output and excessive operation and maintenance costs. The operation and maintenance costs of a plant or equipment is a critical element in the production of products within a highly competitive worldwide environment [5]. Currently, customers are expecting companies to deliver higher quality, reliable goods at a competitive cost. This highlights that the company's plant and equipment should be highly reliable. To uphold highly reliable processing plant, there is a necessity of effective and efficient manufacturing process. Various organizations are attempting to implement TPM as an enabling asset to capitalize on the efficiency of company's plant by creating and sustaining a good relationship among people and their machines [6].

During the last century, the maintenance function has undergone throughout various transformations. The customary approach of maintaining an equipment is to get into action whenever it fails. Thus, TPM has shifted the model of company's old maintenance approach from reactiveness to proactiveness by always preserving the equipment in best condition [9]. TPM offers a permanent, life cycle method, to managing plant system by minimizing equipment breakdowns, production flaws, wastes, and accidents. It includes everybody in an organization, from simple plant operators to senior managers, as well as production support groups to outside suppliers [8]. The aim is to endlessly enhance the availability and avoid the breakdown of an equipment to attain maximum efficiency. For example, [3] conducted an investigative study based on the effect of TPM within a semiconductor manufacturing industry. They came up with an important evidence demonstrating that after implementing TPM in that manufacturing company, there is a significant improvement in plant availability, process performance, productivity, equipment unplanned down time and overall equipment effectiveness (OEE). Additionally, they presented the world standard values for OEE as illustrate in the figure 1 below:

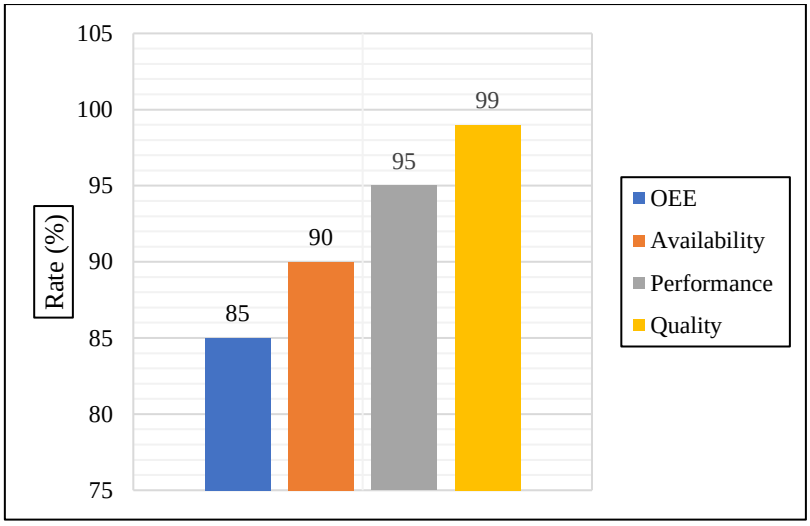

Figure 1: World standard values of OEE [3].

Furthermore, Pradeep and Rodrigues [8] studied the implementation of TPM in diesel electricity generating plant with four units. Their study aimed at comparing overall equipment effectiveness of the four units, and they outlined the significance of speed efficiency and their study presented TPM as a powerful tool to identify previously unseen industrial losses and ineffectiveness. Lixin *et al* [6] conducted study on application of TPM in small and Medium sized enterprises. Change of OEE values before and after implementation of TPM, as shown in the figure 2 below.

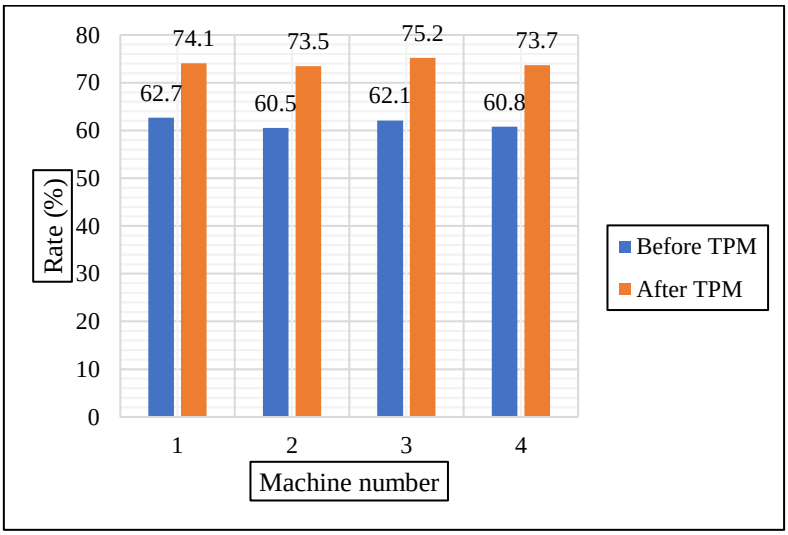

Figure 2: OEE value after implementation of TPM [6].

II.1 Pillars of TPM

In accordance with the Japanese Institute of Plant Maintenance (JIPM) there an eight-pillars involve in the implementation of TPM [9]; [10]; [11]. The Figure 3 below illustrate those eight pillars.

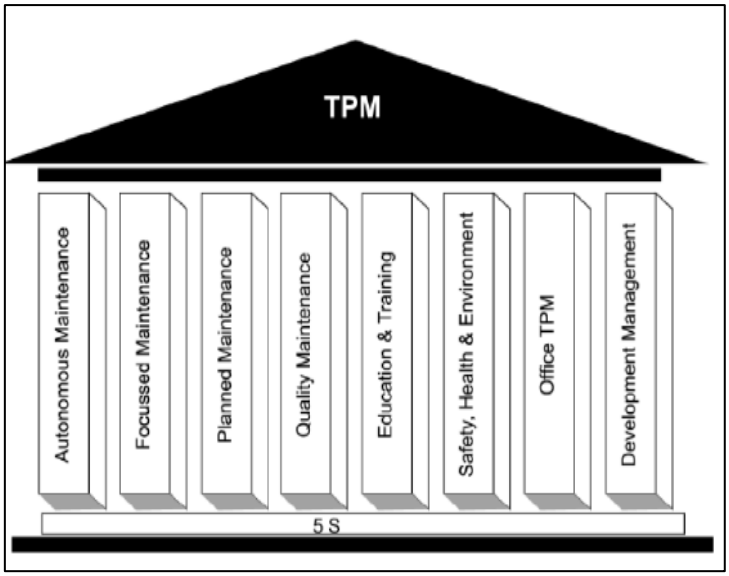

Figure 3: Eight pillars approach for TPM implementation [12].

- Autonomous maintenance

This pillar is designed to foster worker ownership to conduct the following tasks: cleaning, lubricating, tightening, amendment, scrutiny, alteration on production equipment.

- Focused improvement

This pillar emphasizes on the need for creating ways to attain zero loss within all activities, elimination of losses by way of employing results of preventive maintenance analysis broadly and being committed towards cost reduction for resources. The pillar is designed with a goal of reducing losses that may have a negative impact on effectiveness.

- Planned maintenance

To meet customer needs, a product should be defect free. Faultless goods require equipment without fault. Thus, this pillar aims at alleviating spares inventory, high operation and maintenance costs, as well as increasing reliability and effectiveness of equipment, to achieve and sustain machine availability.

- Quality maintenance

This pillar is designed to reach zero defects products, to track and address machinery issues.

- Education and training

Imparting technological, quality control, interpersonal skills, multi-skilling of employees, associating employees to organizational objectives, periodic skill assessment and updating

- Safety, health and environment

Designed to guarantee trustworthy working environment, providing suitable work environment, eliminating incidents of injuries and accidents, and providing standard operating procedures.

- Office TPM

Aims at improving synergy among several business functions, removing procedural hassles, concentrating on addressing issues associated with costs.

- Development management

Minimal problems and running in time on new equipment, utilize learning from existing systems to new systems, maintenance improvement initiatives

III. Results

This section aims at presenting and analysing the data collected from the South African food manufacturing Company. To date, a mixed methodology was used in this study, therefore, we start by analysing the results based on productivity as calculated by employing standard equations, secondly will analyse the results regarding the value of OEE, and finally will analysis the results based on the major barriers hindering successful adoption and implementation of TPM at both sister food manufacturing companies.

III.1 Productivity

This sub-section aims at analysing the manufacturing performance of both sister companies at a company X. This will assist to identify the company that is performing well in terms of productivity. Therefore, the results are presented in the table 1 and figure 4.

Table 1: Total Productivity of both sister food manufacturing companies

	Estimations	Partial productivity	Equations
Subsidiary A			
Crew productivity	$\frac{3\,865\,796}{66\,425}$	58.19	$\frac{\text{output}}{\text{crew input}}$
Material productivity	$\frac{3\,865\,796}{3\,140\,120}$	1.23	$\frac{\text{output}}{Material\ input}$
Power productivity	$\frac{3\,865\,796}{79\,335}$	48.72	$\frac{\text{output}}{Power\ input}$
Total productivity	$\frac{3\,865\,796}{3\,285\,800}$	1.18	$\frac{\text{output}}{(\text{crew} + \text{material} + \text{power inputs})}$
Subsidiary B			
Crew productivity	$\frac{2\,368\,612}{67\,194}$	35.25	$\frac{\text{output}}{\text{crew input}}$
Material productivity	$\frac{2\,368\,612}{1\,008\,693}$	2.34	$\frac{\text{output}}{Material\ input}$
Power productivity	$\frac{2\,368\,612}{64\,150}$	36.92	$\frac{\text{output}}{Power\ input}$
Total productivity	$\frac{2\,368\,612}{1\,007\,694}$	2.35	$\frac{\text{output}}{(\text{crew} + \text{material} + \text{power inputs})}$

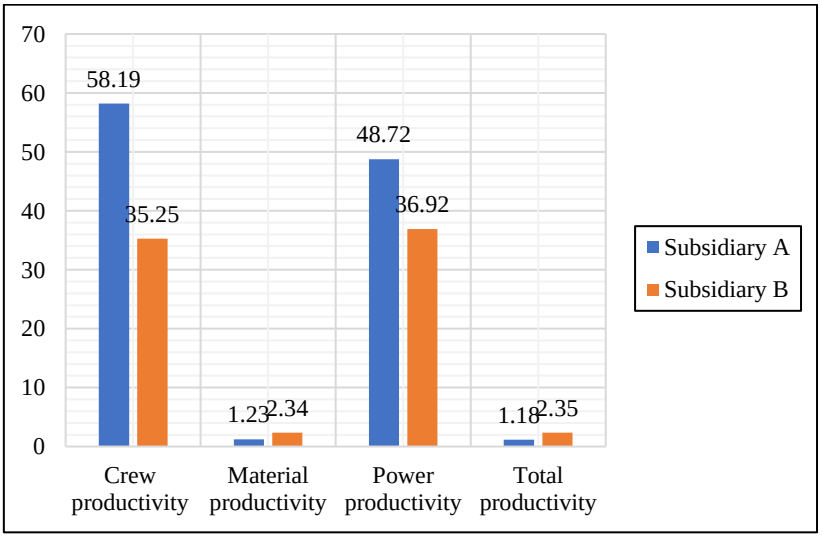

Figure 4: Total Productivity of both sister food manufacturing companies

The first observation, depicted from the figure 4 above is that the subsidiary A demonstrates good results regarding either partial or total productivity. Considering this, a conclusion can be drawn up from the results above that subsidiary A is performing well than subsidiary B with regards to both partial and total productivity. And this has a significant impact on the costs incurred in the operations of both sister companies.

III.2. Overall Equipment Effectiveness

This sub-section aims at measuring the extent of TPM at subsidiary A and subsidiary B at a company X (south African food manufacturing company). This analysis is based on quality, performance, availability, and OEE. Additionally, the results of both subsidiaries are benchmarked with those set up from world standard. To this end, figure 5 below demonstrates this analysis.

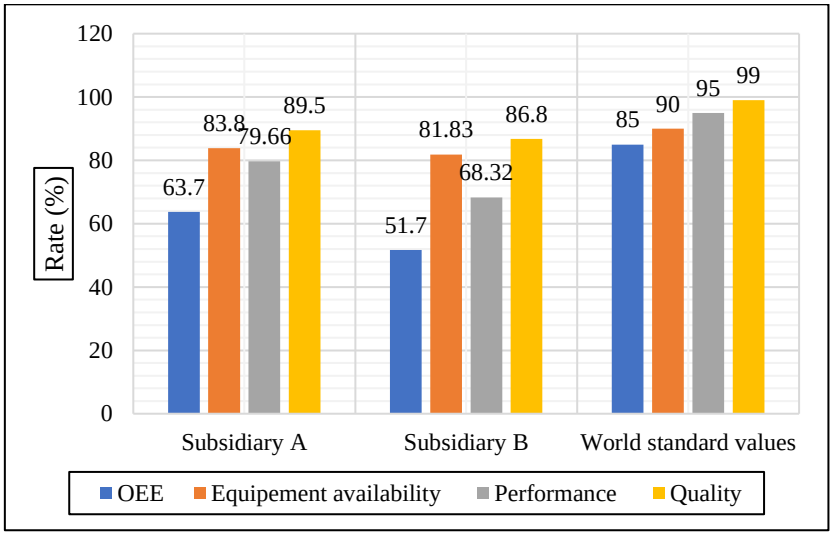

Figure 5: Graphical representation of parameters of OEE and its comparison

The first observation from the figure 5 above, is that the results of subsidiary A and B fall behind the values set up for world standard. The results also demonstrate that subsidiary A has got good results regardless of parameters when comparing to subsidiary B. considering this, it can be concluded that the performance level regarding TPM is good than subsidiary B.

III.3 Challenges faced in implementing TPM

Besides, the results presented above, this study also seek to determine the types of challenges face at both subsidiary A and B when implementing TPM. The data were collected from 527 questionnaires, participants were urged to indicate on a scale of 1 to 5 (where 1 was strongly agree and 5 was strongly disagree). Thus, the results are presented in the figure 6 below:

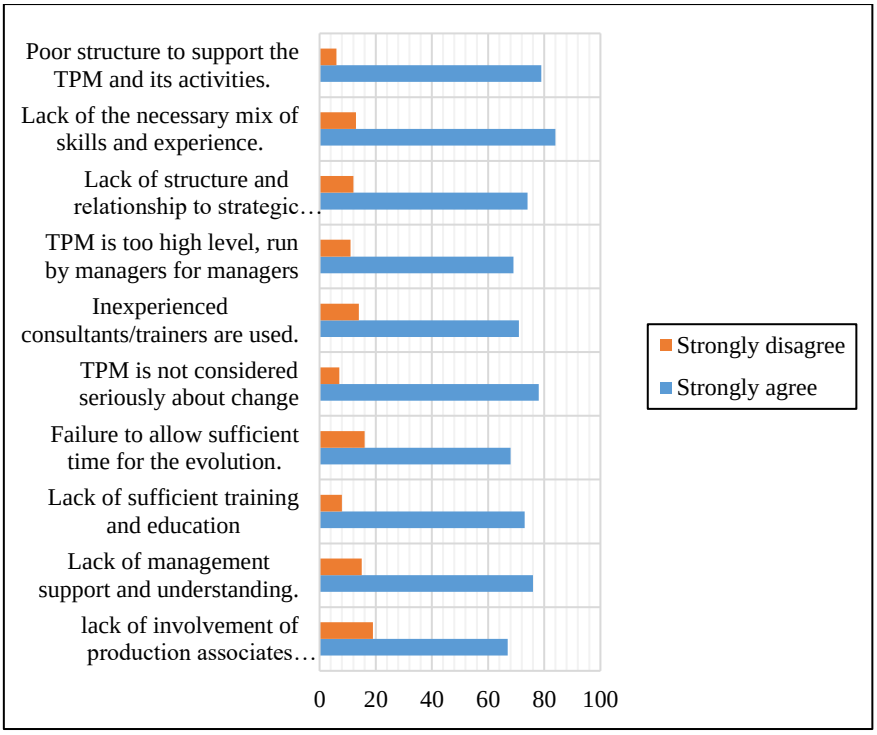

Figure 6: Challenges faced when implementing TPM

From the results above, it can be depicted that paucity of management support, insufficient necessary skills, poor structure to support TPM are the important challenges. For example, insufficient management support is assigned to management not fully recognising the actual objective of the TPM and its activities. Additionally, in case where management view TPM as a way of reducing operation and maintenance crew, this shows that management do not have a clear knowledge of TPM and its goal. The overall aim is to increase the effectiveness of the equipment, not reducing the labour head-count. Lack of sufficient training and education can unsurprisingly cause a decline in OEE and ending in failure to implement innovative and upgraded measures. It takes significant effort to shift human mindset from an old to a modern approach to successfully implement TPM in a lifespan of the plant. The participants report that an effective understanding, education and training are key players when implementing TPM. time needed to fully implement TPM is considerable. Some respondents point out that it could take up to six years before reaching a competitive advantage for the TPM approach. TPM should be considered as a long-run commitment striving for free defective products and not a means of achieving short-run solutions.

Conclusions

In the current highly competitive global market, TPM has proven to be a key competitive approach for business organization. To this end, the present paper recommends TPM as a roadmap for South African food manufacturing industry. This study revealed that the South African food manufacturing company is likely struggling when seeking to fully adopt and implement TPM approach. To this end, it was shown in this study the potential major challenges faced by those two sister companies at a company X where the survey was conducted. Therefore, to successfully implement TPM, it is recommended to the food manufacturing company X to address the various challenges presented in the figure 6. It was also shown in this study that both sister company namely here as subsidiary A and B had less rate of overall equipment effectiveness when comparing to the world standard values, which caused many failures. Furthermore, there is a variation in terms of values of overall equipment effectiveness, performance, availability, and quality at both sister companies. Despite this fluctuation of value, we noticed that subsidiary A has got better performance than subsidiary B regarding productivity and overall equipment performance.

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Biography

Dr Pule Aaron Kholopane is currently a Senior Lecturer and Head of Department in the Department of Quality and Operations Management, Faculty of Engineering and the Built Environment, University of Johannesburg, South Africa. He has both industrial and academic experience for more than twenty years. He has got a Doctorate of Engineering degree from the University of Johannesburg where he has been supervising masters and PhD students during the current decade. He has published several journal and conference research papers. His research areas include project management, process optimizations, manufacturing processes, supply chain management, sustainability, production planning, energy efficiency, waste reduction, product development and marketing, product quality related.

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