

An Exploration of The Extent of Total Productive Maintenance Implementation in the Iron and Steel Industry in Libya

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Abstract: Maintenance concepts have developed steadily due to their importance to factories. Managing maintenance activities significantly improves operating conditions, reduces breakdowns and prevents major equipment failures. In order to achieve the positive impact of maintenance management, Total Productive Maintenance (TPM) had a major role in making a paradigm shift in maintenance management. It has been adopted by many major industrial companies around the world. TPM revolves around integrating the role of the human element in maintenance work, but not only maintenance staff, it goes to make production staff an effective guarantor of the success of the maintenance process. This research aims to explore the importance and extent of implementation of the concepts of TPM in an iron and steel industry in Libya. The data was collected by distributing a questionnaire to survey the opinions of experts in the Libyan Iron and Steel Company (LISCO) which is the biggest company in this sector in Libya. The questionnaire is about the importance and applicability of the concepts of TPM and the most important obstacles facing the implementation process. The results of research showed that the efforts of company to implement TPM were unsuccessful. The results of the research indicated that most of those who received training courses in the field of TPM are old workers, and then the training programs stopped. Stopping of the training courses led to the failure of implementation of TPM. The results also showed that there is an awareness of the concept and importance of TPM. However, there is another reason of failure which is the organizational structures of the company's factories, which are based on the idea of separating the operation and maintenance departments. Although a number of training courses for operational and maintenance staff were implemented, these efforts did not lead to the actual implementation of the TPM concept, as there are types of maintenance operations that require specialized courses that take a long time. Also, the first steps of implementation were not accompanied by any change in the pattern of the organizational structures of the company's factories. The work environment in the company's factories in Libya may differ from other environments. Imported frameworks often do not receive the response and success as they found in their original environments. Therefore, such principles and concepts need to be coordinated and adapted to different industrial environments.

Key words: Maintenance, Productive, operations.

1 introduction

Managing the maintenance function effectively can severely affect a company's profitability by increasing throughput, decrease inventory and also lead to excellence due-date performance. Total productive-maintenance (TPM) is a proven and successful procedure for introducing maintenance considerations into organizational activities. It involves operational and maintenance staff working

together as a team to reduce wastage, minimise downtime and improve end-product quality [1]. TPM builds a strong relationship between maintenance and productivity, showing that good care and up-keep of equipment will result in higher productivity [2]. The goal of the any TPM program is to improve productivity and quality along with increased employee morale and job satisfaction [3]. Earlier preventive maintenance was considered as non-value adding process, but now it is an essential requirement for a longer life cycle of machines in an industry. TPM is an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns, and promotes autonomous operator maintenance through day-to-day activities involving the total workforce. Lazim noted that more importantly, the role of top management stimulates the contribution of operators to achieve zero breakdowns, zero stoppages and safer working environment[4]. The objective of this study is to explore the extent to which factory workers, including managers, engineers, and operation and maintenance technicians, understand the principles of total production maintenance. In addition to figure out the ability of the company's plants to implement these principles and identifying the factors that negatively affect the implementation process.

2 Literature review

2.1 Implementation of TPM

Total Productive Maintenance ranging from maintenance techniques, framework of TPM, overall equipment effectiveness (OEE), TPM implementation practices, barriers and success factors in TPM implementation.[5]. The implementation of TPM should be a continuous and incremental process to broaden the coverage of TPM as well as improve the OEE level at each round [6]. The leader and the management of enterprise play a key role in the process. It is necessary to have a sustained system to prevent the operator from returning to the state before improving. The sustained system is holistic by emphasizing in establishing standards, visualization, reutilization, patrol system and continuous improvement. TPM aids management in developing new policies and operation strategies towards improving production performances to realize the company's full potential in today's highly competitive manufacturing environment [7]. The contribution of this study reveals that strategic TPM initiatives can significantly contribute towards the improvement of manufacturing performance in the organization. This study highlights the contributions made by holistic TPM implementation to improve overall organization performances such as quality, cost, speed and increase staff morale.

2.2 The 5S Methodology Technique

The 5S concept developed by the Japanese and the original concept of 5-S was developed in the early 1980s.[2],[7],[8]

They are:-

- 1) Sort
- 2) Set in order
- 3) Shine
- 4) Standardize
- 5) Sustain

5S is a working philosophy that permits users to create a structured plan to maintain the classification, order, and cleanliness regularly, allowing profitability, health, environment operation, personnel morale, reliability, performance, and therefore competitiveness of the company to be improved instantly.

The need for 5S methods to be implemented is one of the first steps taken in the Lean Management Strategy, increasing the organization's productivity and employee performance. In addition, due to 5S implementation, the factory now has a clean environment, workplace safety is maintained, and product quality is improved, accidents are easy to identify and avoid, unnecessary waste and costs are minimized, the product can now be finished before the deadline [9].

Table 1. 5S phases and descriptions. [2]

5S	Description
Seiri (organization, sorting).	To remove all unnecessary tools and parts and keeping only the essential items.
Seiton (setting order of flow).	To arrange the work, employees, parts, equipment, so that everything is sorted into its proper place.
Seiso (shining, cleaning).	To clean all the workstation and all the equipment and apparatus, keep it clean and tidy so that next user will have an easier time doing their job.
Seiketsu (standardize, visual control).	To ensure procedures and setups throughout the operation are followed by the employees.
Shitsuke (sustain, discipline, and habit).	To make it a way of life and as a culture so that it can be a habit in a worker's daily work routine.

2.3 The eight pillars of TPM:

The eight pillars of TPM defines as a system for maximizing production effectiveness of any industry [10]. The summary of eight pillars is given in table 2.

TPM is multi-faceted and best represented as a House of TPM as shown in figure 1. The key constructs include a 5S foundation and eight pillars of maintenance-relevant activities, namely autonomous maintenance, focused maintenance, planned maintenance, quality maintenance, education and training, early management, TPM in the office and safety & environment. Not all pillars can be implemented in an intuition [6]. Some cases only involve a single or selective pillars, e.g. autonomous maintenance [11], planning maintenance [12], autonomous maintenance and focused maintenance [13], among others [6].

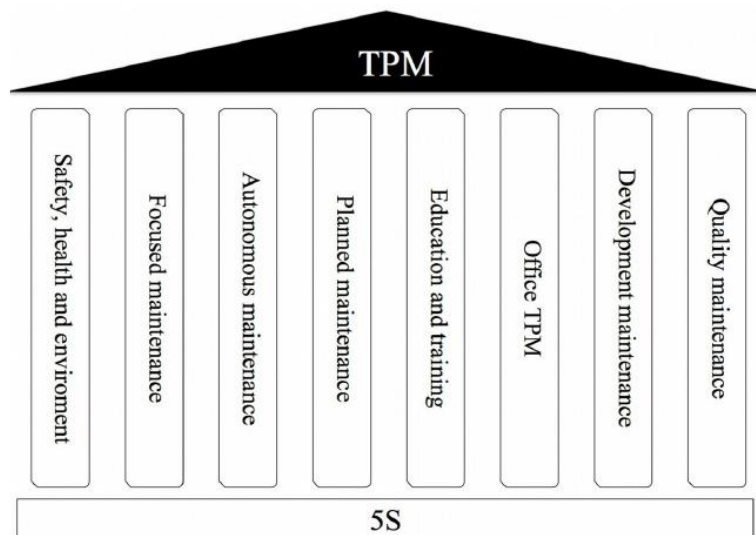


Fig. 1. House of TPM [14]

Although this model of the eight pillars of total productivity maintenance is adopted by many companies and researchers, there are some slight differences in the nomenclature of these eight pillars. But in most cases, the general framework is the same. It is usually used to measure the extent to which the principles of TPM are understood and applied in the concerned institution.

Table 2. Summary of Eight Pillars of TQM

TPM Pillars	Description	Advantages
Autonomous Maintenance	Hands operators of equipment responsible for carrying out basic maintenance of equipment	Operators feel responsible for their machines: equipment becomes more reliable
Planned Maintenance	Maintenance scheduled using the historical failure rate of equipment	Maintenance can be scheduled when production activities are few
Quality Maintenance	Quality ingrained in the equipment to reduce defects	Defect reduction & consequent profit improvement
Continuous Improvement	Use of cross-functional teams for improvement activities	Improves problem-solving capabilities of the workers
Early Equipment Management	Design of new equipment using lesson learned from previous TPM activities	New equipment achieves full the potential in a shorter period
Education & Training	Bridging of the skills and knowledge gap through training of all workers	Employees gain the necessary skills to enable them to solve the problems within the organization
Health Safety & Environment	Providing of an ideal working environment devoid of accidents and injuries	Elimination of harmful conditions & healthy workforce
TPM in the office	Spread of the principles to administrative functions within an organization	Support functions understand the benefits of these improvements

3 Research Method

The research was conducted in the factories of Libyan Iron & Steel Company in Libya, parameters measured are the eight pillars of TQM as shown in table 2. The method of the data collection was done through questionnaires. Population in this study is operator, technician, staff, assistant, head of section and the directors of departments.

3.1 Data Collection:

In this study, the descriptive analytical method was used, data were collected using a questionnaire, 100 paper copies were distributed in the factories of the Libyan Iron and Steel Company (LISCO), 87 of them were returned. However, 74 questionnaires were considered valid and capable of analysis. The questionnaire was divided into three parts, the first contains general information for members of

the study community, The second is intended to explore the respondents' understanding and experience in the scope of TPM and the third part contains questions concerning the level of the current situation of the company's factories and the extent of the need for modern maintenance concepts.

These questions were based on the recommendations of previous studies in the field of TPM. The questionnaire contained eight main pillars of total productive maintenance, represented in the level of training and qualification in understanding maintenance programs and techniques using modern methods, the level of maintenance planned by the operations department, the level of safety and health in the field of work, the level of control and control in the field of operations, the level of maintenance office productivity, the level of maintaining and improving the quality of production processes, the level of maintenance carried out by operation and maintenance workers and finally the level of continuous improvement of operations. A blank was also placed if there is any suggestion or opinion that the target of this questionnaire would like to add.

3.2 Data Analysis and results discussion:

In this section, the answers of respondents have been analyzed and discussed as they have been divided into three main sections.

Section 1. General Information:

Figure 2. shows the demographic profile of respondents who were selected from the Libyan Iron & Steel Company (LISCO) to be the sample of this research.

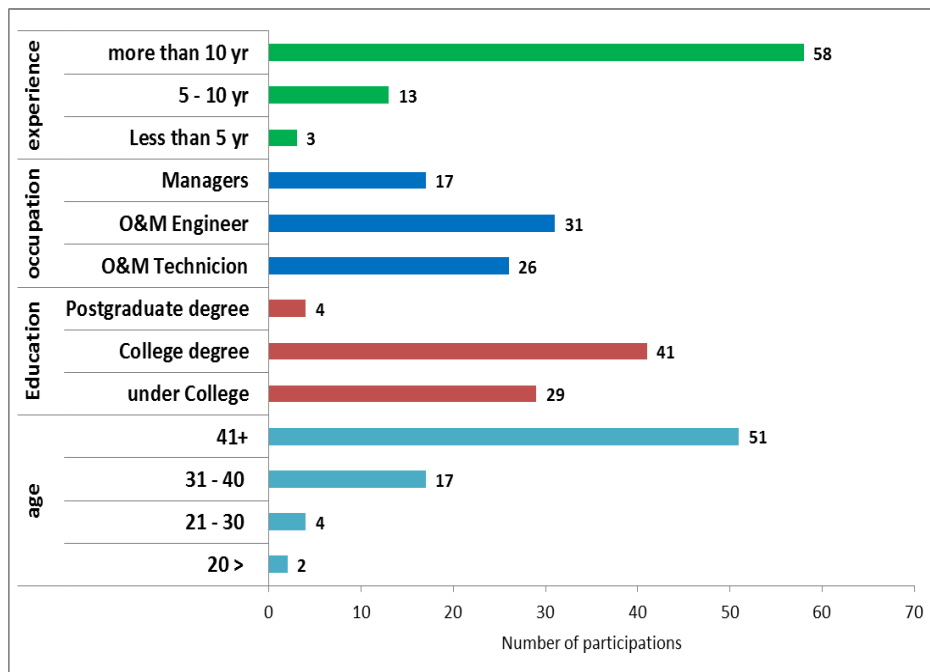


Fig. 2. The demographic profile of respondents

According to figure 2., it can be seen that most of the respondents have long experience in the field of work, hold college qualifications, as well as the position of most of them as maintenance and operation engineers. It indicates that the company has qualified workers in their field of work. The results also indicate that the company has employed many university-qualified holders, which include operation and maintenance engineers in various engineering fields.

Section 2. Respondents' understanding and experience of TPM

The figures (3, 4 and 5) show the extent to which the respondents understand the principles of TPM, as well as the impact of the received training courses on the understanding of TPM.

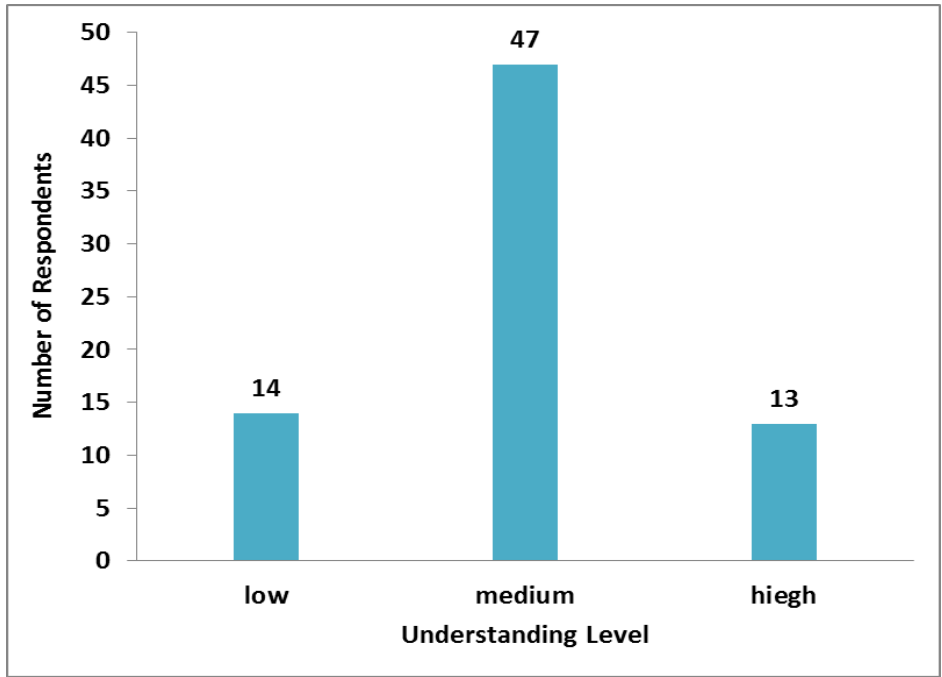


Fig. 3. Respondents' understanding of TPM

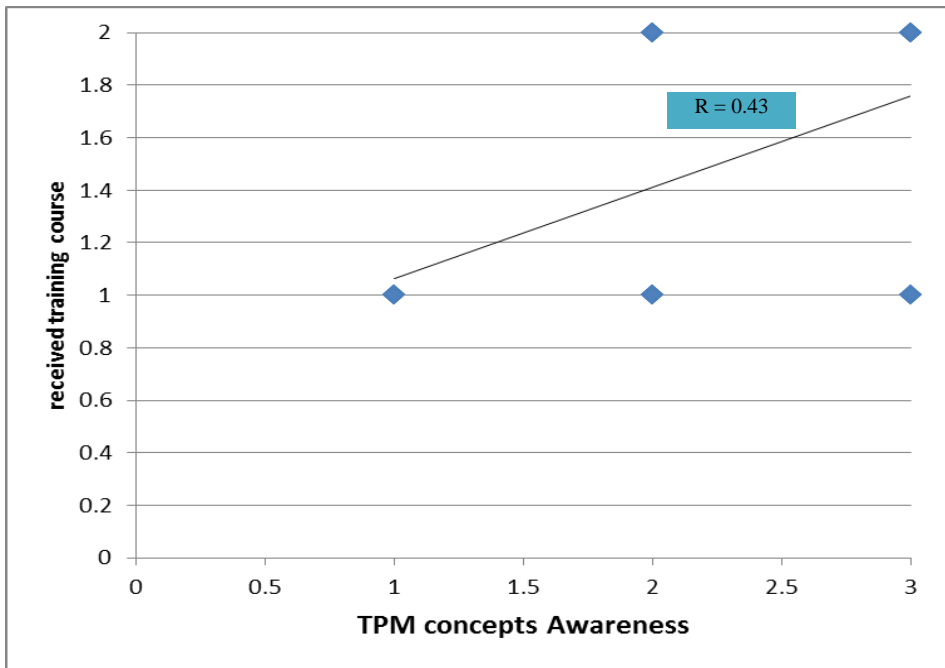


Fig. 4. The relationship between TPM awareness and received training courses

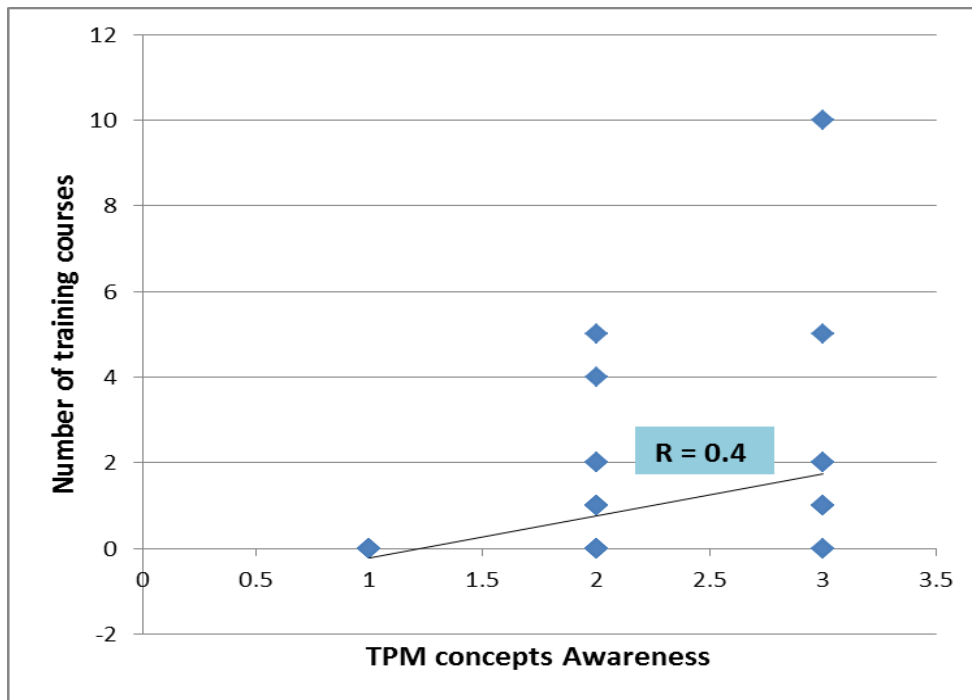


Fig. 5. The relationship between TPM awareness and number of training courses

Figures (3, 4 and 5) shows that the majority of the respondents confirmed that they have a moderate awareness of maintenance concepts, and although about half of the respondents received training courses, these courses did not significantly affect the understanding of maintenance principles. Likewise, the number of cycles had no effect on increasing the understanding of maintenance.

This indicates that the quality and content of the training courses in the field of maintenance were not as effective as planned, and therefore did not achieve their objectives regarding the implementation of the maintenance program in the company's factories.

Section 3: TPM Pillars

In this research, Likert scale (1-5) was used to measure the eight pillars of TQM at Libya Iron and Steel Company (LISCO) as follows:

Very low	Low	Neutral	High	Very high
1	2	3	4	5

The results of measuring the extent to which of eight pillars of TQM are implemented in the company as shown in table 2.

Table 3. The Eight Pillars of TQM in the Company

TPM Pillars	The average based on Likert Scale 1 – 5	Level
Education & Training	Neutral	2.68
Planned Maintenance	Neutral	2.98
Health Safety & Environment	Neutral	3.08
Operation control	Neutral	2.95
TPM in the office	Neutral	2.78
Quality Maintenance	Neutral	3.22
Early Equipment Management	Neutral	3.17
Continuous Improvement	Neutral	3.09
Overall level	Neutral	3.00

The results of applying the pillars of TPM in the company's factories were natural. These results are consistent with what has been reached with regard to understanding and benefiting from training courses as well as participating in the implementation of maintenance programs in the company's factories.

4 Conclusion

Although applying the principles of TPM has succeeded in many companies around the world, these principles have not been successful within the factories of the Libyan Iron and Steel Company (LISCO).

The company has attempted to implement TPM principles years ago, however, those efforts were unsuccessful. The results of the research indicated that most of those who received training courses in the field of TPM are old workers, and then the training programs stopped, this is what the research results showed. One of the most important reasons that led to the failure of implying the principles of TPM is the quality of training programs in addition to the weak role of culture in this field. There are also other factors that contributed to the failure to fully implement the principles of TPM, which is the lack of support to spare parts and maintenance supplies. The results also showed that there is an awareness of the concept and importance of TPM. However, there are some reasons that hindered the implementation of TPM plans.

One of the most important of these obstacles is the organizational structures of the company's factories, which are based on the idea of separating the operation and maintenance departments. Although a number of training courses for operational and maintenance staff were implemented, these efforts did not lead to the actual implementation of the TPM concept, as there are types of maintenance operations that require specialized courses that take a long time. Also, the first steps of implementation were not accompanied by any change in the pattern of the organizational structures of the company's factories. The work environment in the company's factories in Libya may differ from other environments. Imported frameworks often do not receive the response and success as they found in their original environments. Therefore, such principles and concepts may need to be coordinated and adapted to different industrial environments.

Conflict of Interest

This is to certify that all authors have seen and approved the manuscript being submitted and to declare that they have no conflicts of interest.

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